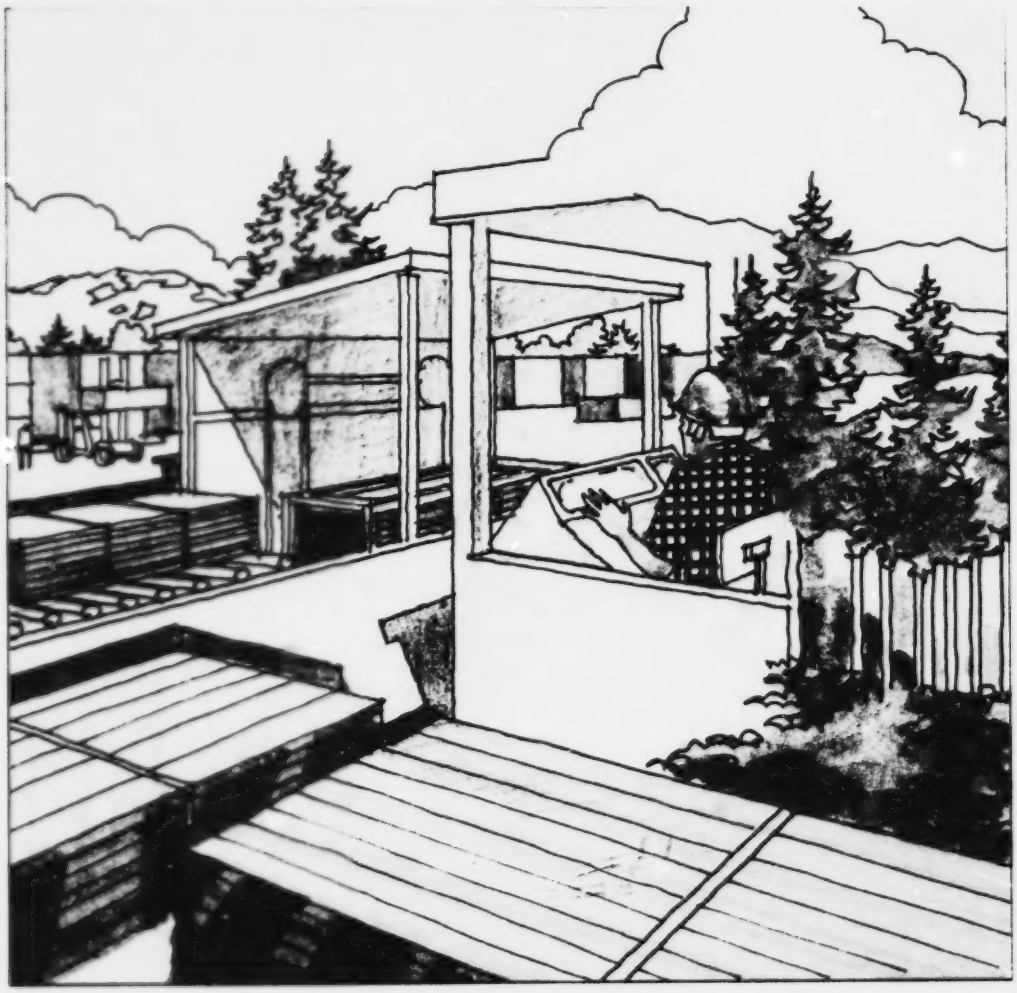
CHLOROPHENATE WOOD PROTECTION

RECOMMENDATIONS FOR DESIGN AND OPERATION



Environment Canada Environnement Canada

BC Ministry of Environment

CHLOROPHENATE WOOD PROTECTION

RECOMMENDATIONS FOR DESIGN AND OPERATION

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For

The Executive Committee of the
B.C. CHLOROPHENATE
WOOD PROTECTION TASK FORCE

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INTRODUCTION

The B.C. Chlorophenate Wood Protection Task Force

In order to respond to the environmental and health concerns related to the use of chlorophenates at wood protection facilities, the Environmental Protection Service, during 1981, proposed the establishment of the British Columbia Chlorophenate Wood Protection Task Force. The members of the Task Force included representatives of federal and provincial government agencies, forest industry companies and forest industry labour unions (see page xi). The Task Force was charged with the responsibility of investigating the use of chlorophenates at wood protection facilities in British Columbia and developing practical measures for environmental and health protection. The Executive Committee of the Task Force was the decision-making body which would review the recommendations provided by the members of the General Committee.

The Environmental Protection Service retained EVS Consultants Ltd. to conduct a technical review of wood protection practices in British Columbia and to develop a draft "Code of Good Practice" for the design and operation of wood protection facilities (1). The Code provides recommendations for workers' health and safety and for the storage, transportation and disposal of chlorophenate liquids and contaminated water and solid wastes.

The draft referred to as the "Code of Good Practice" was presented to the Task Force by the contractor during August 1981. This initiated a two-year review process by the Task Force which included input from other experts in both industry and government. The result of this comprehensive development and review process is the publication of this document which will be referred to in the text as the "Code".

B.C. CHLOROPHENATE WOOD PROTECTION TASK FORCE MEMBERS

EXECUTIVE COMMITTEE

Dr. A. McIntyre Task Force, Co-Chairman (1981-1982)	Environmental Protection Service, Environment Canada
Mr. K. Wile Co-ordinator, Code Preparation and Review Co-Chairman (1983)	Environmental Protection Service, Environment Canada
Dr. R. Kobylnyk Task Force, Co-Chairman	Pesticide Control Branch, B.C. Ministry of Environment
Mr. B. Manna Incineration Research Sub-Committee, Chairman	Waste Management Branch, B.C. Ministry of Environment
Mr. T. Horn	Waste Management Branch, B.C. Ministry of Environment
Mr. L. Hubbard	Waste Management Branch, B.C. Ministry of Environment
Mr. A.L. Riegert	B.C. Workers' Compensation Board

GENERAL COMMITTEE

(Includes Members of the Executive Committee)

Mr. P. Gilbert	Council of Forest Industries of B.C.
Mr. D.J. Barker	B.C. Wharf Operators Association
Mrs. V. Ledger	International Woodworkers of America
Mr. R.M. McDonald	Pulp and Paper Workers of Canada
Mr. B. Payne	Canadian Paperworkers Union
Mr. P. Brown	International Longshoremen's and Warehousemen's Union
Dr. F. Cedar	Agriculture Canada
Mr. J. Patterson	Fisheries and Oceans Canada

Intent of the Code

This "Code" is a compendium of recommendations from the Executive Committee of the B.C. Chlorophenate Wood Protection Task Force intended to protect both the environment and workers from harmful exposure to chlorophenates. Although the "Code" is not part of any environmental legislation it reflects the intent of the Federal Fisheries Act, Provincial Waste Management Act and Workers' Compensation Board Industrial Health and Safety Regulations (see Section 3).

A significant amount of background information has been included in the "Code" in order to provide readers with the factual basis which supports the suggested designs and recommended operational practices. Although the recommendations are specific, the "Code" user should focus on achieving the objectives of protecting the environment and workers from harmful exposure to chlorophenates. Site-specific circumstances may require the modification of certain recommendations in order to best achieve these objectives.

It is the intent of the Executive Committee that new facilities will generally comply with all provisions in the "Code". However, in regard to existing facilities, it is expected that companies will make all practicable modifications necessary to meet the objectives of the "Code". More detailed comments on the implementation of provisions of the "Code" will be found in Sections 3.1 and 3.2 (Personnel Protection), Sections 5.1 and 5.2 (Design Features), Section 6 (Operating Practices), Section 7 (Transportation) and Section 8 (Disposal). The Task Force believes that the proper implementation of the provisions of the "Code" will allow the continued beneficial use of chlorophenates for wood protection and will protect both the environment and workers from potential harmful effects.

1 THE NEED FOR WOOD PROTECTION

1.1 Introduction

For the purposes of this "Code", "Wood Protection" refers to the treatment of freshly cut lumber with a chemical agent to prevent the growth of sapstain and mould fungi. The fungi degrade the quality of the lumber and thereby reduce its marketability, and also can promote wood decay. Water solutions of sodium chlorophenates are commonly used for sapstain and mould control in British Columbia. Chlorophenates are effective fungicides because they are toxic to micro-organisms. These chemicals are also toxic to humans and aquatic organisms, therefore their use in industry must be carefully controlled. The "Code" is intended to provide consistent guidelines for the design and operation of wood protection facilities in a manner which will protect workers and the environment from harmful exposure to chlorophenates.

1.2 Sapstain and Mould Fungi

Freshly cut, unseasoned lumber is susceptible to attack from the spores of sapstain fungi and mould fungi which are carried by wind and insects (2). Sapstain fungi develop rapidly, penetrating the sapwood within 24 hours under warm and humid conditions. The mould fungi grow only superficially on wood, rarely penetrating to any depth.

Sapstain fungi do not attack the structural components of the wood. However, due to the natural pigmentation of the fungi, the wood will acquire blue or black stains. Mould fungi also do not cause structural damage to the wood, but in severe cases they can cause unsightly blemishes. Both sapstain and mould fungi can promote invasion by other decay organisms which can cause structural damage to the wood.

Sapstaining of lumber may be especially severe during overseas transit under the warm, moist conditions in a ship's hold. Dark

discolouration of the lumber is often objectionable to the buyer, and may be so unattractive that domestic and foreign customers will not purchase stained lumber.

1.3 Control of Sapstain and Mould Fungi

The growth of sapstain organisms requires warm temperatures (10-35°C), oxygen, water and a food source(the wood). The undesirable development of these organisms on lumber is controlled in practice by manipulating these basic growth requirements. For example, sapstain growth is minimized in certain areas of British Columbia during periods of freezing winter temperatures. Kiln drying of lumber may also be used to inhibit sapstain growth by lowering the moisture content below 20 percent. However, kiln drying is not economically practical in areas of high rainfall and humidity, and chemical agents have been developed to inhibit sapstain growth by "poisoning" the wood food source.

Several commercial sapstain control chemicals have been developed and are used worldwide. In North America, the most successful and widely used active ingredients are sodium tetrachlorophenate and sodium pentachlorophenate (the sodium salts of tetrachlorophenol and pentachlorophenol). Both chemicals are contained in formulations used in British Columbia, with tetrachlorophenate predominating over pentachlorophenate in a ratio ranging from 2:1 to 4:1. Pentachlorophenate is the primary active ingredient in formulations commonly used in the United States. These chemicals are dissolved in caustic solution and are directly applied to unseasoned lumber, either by spray application or by submerging the lumber in a "dip" tank containing the treatment solution (Section 4). The lumber is generally retreated if it is recut, trimmed, planed, or remanufactured.

The development of alternative chemical methods for sapstain control is the subject of intensive ongoing research. This research includes the search for effective inhibitive chemicals which are not as environmentally persistent and toxic as chlorophenols. Attention is also

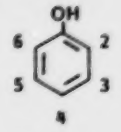
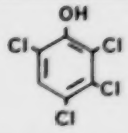
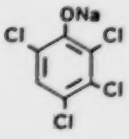
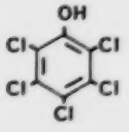
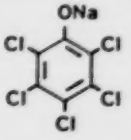
being given to the development of chemical agents which act passively, by making wood unpalatable to attacking organisms.

None of these alternatives have been developed to the point of widespread practical use. For the immediate future, chlorophenate treatment will probably remain the primary control technique which combines effectiveness and economy. However, viable alternatives will probably be available within a few years.

1.4 The Value of Wood Protection

More than 80 percent of the lumber currently shipped overseas is unseasoned and requires protection against sapstain and mould fungi. The total annual value of lumber exported from British Columbia is 1.3 billion dollars (1980) and much of this market would be lost if sapstain occurred. Therefore, the control of sapstain and mould organisms is vital to the British Columbia economy.

TABLE 1. COMMERCIAL USES OF TETRA- AND PENTACHLOROPHENOL COMPOUNDS

CHLOROPHENOL COMPOUND	CHEMICAL STRUCTURE	COMMON COMMERCIAL USES*
TERMINOLOGY FOR SPECIFYING CHLORINE POSITIONS ON THE PHENOL MOLECULE		THE NUMERICAL PREFIX IN THE COMPOUND NAME INDICATES THE POSITION OF THE CHLORINE ATOM(S)
2,3,4,6-TETRACHLOROPHENOL		PESTICIDE
2,3,4,6-SODIUM TETRACHLOROPHENATE (the water soluble sodium salt of 2,3,4,6-tetrachlorophenol)		SAPSTAIN CONTROL AGENT (the primary active ingredient of Canadian formulations commonly used in British Columbia)
PENTACHLOROPHENOL		WOOD PRESERVATIVE (termiticide, fungicide) CONTROL AGENT FOR MOULD ON INERT SURFACES (construction industry) CONTROL AGENT FOR MOULD ON LEATHER SHOE UPPERS FUNGICIDE IN PROTEIN-BASED LATEX PAINTS
SODIUM PENTACHLOROPHENATE (the water soluble sodium salt of pentachlorophenol)		SAPSTAIN CONTROL AGENT (the secondary active ingredient in Canadian formulations; the primary active ingredient in U.S. formulations) ANTIFUNGAL, ANTIBACTERIAL AGENT: - in adhesives (starch, vegetable and animal protein-based) - on inert surfaces (construction materials) - on leather, hides and in tanning solutions - in paint (protein-based) - in drilling muds - photographic solutions - paper pulp and fibre board - textiles (yarns and cloth) - industrial recirculating cooling waters

*BASED ON INFORMATION IN REFERENCES 3 AND 4

2 CHLOROPHENOLS AND CHLOROPHENATES

2.1 Production and Use

Chlorophenols are synthetic organic compounds which are commercially manufactured by reacting chlorine with phenol. Figure 1 shows the simplified reaction chemistry for the production of one specific chlorophenol (pentachlorophenol) by the catalytic chlorination of phenol.

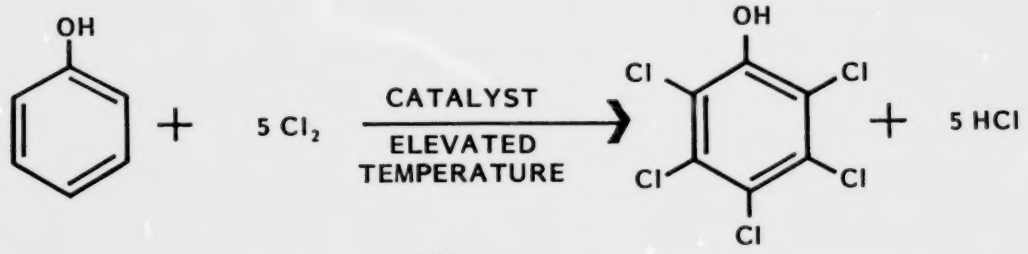
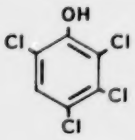
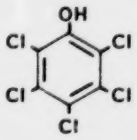


FIGURE 1. THE CHEMISTRY OF PENTACHLOROPHENOL PRODUCTION

A previous Environmental Protection Service publication, authored by P.A. Jones, presents detailed information on the production, importation and use of chlorophenols in Canada (3). There are 19 possible chemical forms (isomers) of chlorophenol, differing in the number and position of chlorine atoms attached to the phenol molecule. Seven of these compounds are used commercially, either directly as biocides or pesticides, or as intermediates in the manufacture of pesticides. The more highly chlorinated chlorophenols are the most potent biocidal agents

TABLE 2. PHYSICAL AND CHEMICAL PROPERTIES OF TETRA- AND PENTACHLOROPHENOL

CHLOROPHENOL COMPOUND	2,3,4,6-TETRACHLOROPHENOL	PENTACHLOROPHENOL
CHEMICAL STRUCTURE		
MOLECULAR WEIGHT	232	266
PHYSICAL APPEARANCE	buff-brown solid	light brown solid
SPECIFIC GRAVITY	1.60	1.98
SOLUBILITY IN WATER (mg/litre @ 20°C)		
Chlorophenol Form	70	14
Chlorophenate Form	N.A.	330000
SOLUBILITY IN METHANOL		
(% @ 80°C)	N.A.	63
Petroleum Solvent (% @ 80°C)	N.A.	15-20
MELTING POINT (°C)	69-70	188-191
BOILING POINT (°C @ 760 mmHg)	288	310
VAPOUR PRESSURE		
(mmHg @ 20°C)	N.A.	.0001
(mmHg @ 100°C)	1.0	.12

**BASED ON INFORMATION IN REFERENCE 5*

N.A. = NOT AVAILABLE

because the biocidal activity of chlorophenols increases with the degree of chlorination. The commercial uses of tetrachlorophenol and pentachlorophenol compounds are shown in Table 1.

Wood preservative applications represent the major Canadian use of tetrachlorophenol and pentachlorophenol compounds. Pressure treatment of wood with pentachlorophenol dissolved in light hydrocarbon oil is commonly used for the long-term preservation of poles, posts and lumber. Water solutions of the sodium salts of tetrachlorophenol and pentachlorophenol are used almost exclusively in British Columbia to control sapstain in lumber destined for overseas markets.

Jones estimates that 784 tonnes of chlorophenol active ingredient was used in solutions to treat 6.6 billion board feet of lumber for sapstain control in British Columbia during 1977 (3). More recent data indicate that approximately 600 tonnes of chlorophenol active ingredient was used to treat 10 billion board feet in 1979 (6).

2.2 Physical and Chemical Properties

The water soluble sodium salts of tetrachlorophenol and pentachlorophenol are the primary active ingredients in treatment solutions used for sapstain control in British Columbia. These water soluble salts are called chlorophenates. The corresponding chlorophenol and chlorophenate forms have distinctly different properties. The physical and chemical characteristics of the chlorophenol compounds in pure form are summarized in Table 2.

Tetrachlorophenol and pentachlorophenol are solids at room temperature and these chlorophenols can be volatilized at elevated temperature. Both compounds are sparingly soluble in water and highly soluble in oils. The high solubility of pentachlorophenol in light petroleum oil has led to its widespread use in pressure impregnation of wood for long-term wood preservation.

TABLE 3. COMMERCIAL SAPSTAIN CONTROL FORMULATIONS IN BRITISH COLUMBIA

COMMERCIAL NAME	FORMULATOR	COMPOSITION			
		CHLOROPHENOL ACTIVE INGREDIENTS (Percent by Weight)			ADDITIVES
		TETRA*	PENTA**	OTHER***	
WOODBRITE 24	VAN WATERS & ROGERS LIMITED	16.3	7.7		SODIUM TETRABORATE BUFFER
DIATOX	DIACHEM LTD.	19.4	4.8		UNSPECIFIED BUFFERS
WOODSHEATH	WALKER BROS. LTD.	5.4		1.5	UNSPECIFIED BUFFERS COLOUR WAX
WOODSHEATH (SEABRITE)	WALKER BROS. LTD.	11.35		2.85	UNSPECIFIED BUFFERS COLOUR WAX
ALCHEM 4135	ALCHEM LTD.	27.0			UNSPECIFIED BUFFERS TRIBUTYLTIN OXIDE

SODIUM TETRACHLOROPHENATE

**SODIUM PENTACHLOROPHENATE*

***UNSPECIFIED CHLOROPHENATES*

Chlorophenates are used for sapstain control because water solutions are generally easier and safer to use for the simple surface treatments employed at sawmills. In the preseces of alkaline water, chlorophenols ionize to the water-soluble chlorophenate form. Figure 2 illustrates the reversible conversion between pentachlorophenol and its water-soluble pentachlorophenate form.

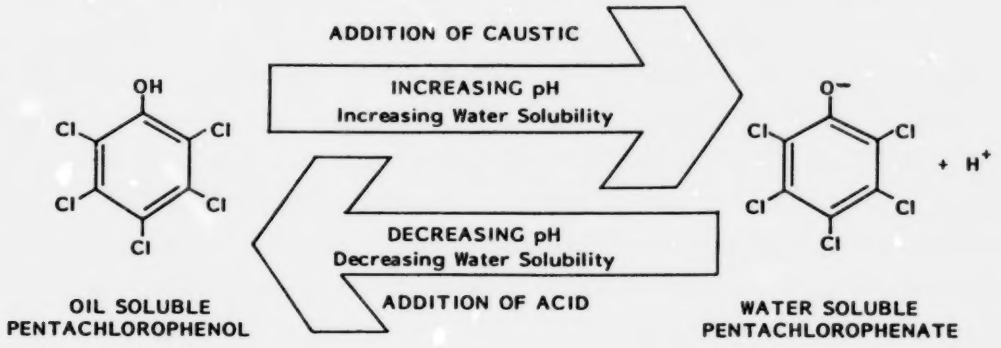


FIGURE 2. THE pH-DEPENDENT EQUILIBRIUM BETWEEN PENTACHLOROPHENOL AND PENTACHLOROPHENATE

The relative proportion of the two chemical forms in water solution is primarily determined by the pH of the solution. As the pH increases, the chlorophenol form is converted to the ionized chlorophenate form and the water solubility is increased dramatically. For example, at pH 3 (acidic conditions), both tetrachlorophenol and pentachlorophenol are less than 1% ionized. If the pH is increased to 7 by adding sodium hydroxide, both compounds are ionized almost completely to the soluble chlorophenate compounds. In contrast to the chlorophenols, chlorophenates in water solution are not appreciably volatilized.

2.3 Commercial Sapstain Control Formulations

Five commercial formulations of chlorophenates most commonly used for wood protection in British Columbia are shown in Table 3. All of these products are registered under the Federal Pest Control Products Act. The major active ingredient in these formulations is tetrachlorophenate, although pentachlorophenate usually is present. This is in contrast to comparable United States formulations which utilize pentachlorophenate as the primary active ingredient.

Commercial formulators utilize the enhanced solubility of chlorophenates at high pH to produce concentrated water-based treatment solutions. These formulations are produced by dissolving chlorophenol compounds in alkaline (high pH) sodium hydroxide solution. Buffers such as sodium tetraborate normally are added to commercial solutions in order to maintain the alkaline condition.

Commercial concentrates are diluted to 0.5 to 1 percent total chlorophenate concentration and applied directly to wood by dipping or spraying. As the treatment solution is absorbed, the natural acidic condition in the wood lowers the pH and causes the ionized chlorophenates to revert to the insoluble chlorophenol form. When this occurs, the chlorophenol compounds become strongly "fixed" or adsorbed into the wood.

2.4 Environmental Effects

Tetrachlorophenol, pentachlorophenol and their sodium salts are highly toxic to aquatic organisms. Both short-term (acute) and long-term (chronic) toxic effects are observed. Chlorophenols are sufficiently persistent in the environment to justify concern about significant long-term effects of major or repeated minor releases to waterways.

2.4.1 Distribution in the Natural Environment. The resistance of tetrachlorophenol and pentachlorophenol to natural breakdown in the environment has led to its widespread dispersal in trace quantities (generally at levels of the order of parts per billion). Chlorophenol presence has been detected and documented in winter snowpacks, water, landfill leachates, sewage effluents, sediments, and in aquatic and terrestrial organisms. Studies undertaken for the Environmental Protection Service in British Columbia have shown that chlorophenols were present in sediments, water and biota adjacent to chlorophenate wood protection facilities located on the Fraser River and on the lower east coast of Vancouver Island (7). This contamination was caused by small but continuing releases of chlorophenate solution from the sapstain control operations.

2.4.2 Acute Aquatic Toxicity. Exposure of fish to chlorophenates can cause immediate harmful effects and can cause death within a short period of time. Chlorophenol compounds interfere with the basic metabolism of fish, leading to energy starvation. Consequently, the acute toxicity of these compounds is relatively non-selective with respect to fish species (8).

The toxicity of sodium pentachlorophenate to salmonid fish species is illustrated in Table 4. Sensitive fish species are killed in a time frame of hours to days by exposure to pentachlorophenate concentrations of the order of 100 parts per billion. Exposure to concentrations in the parts per million range can cause death within minutes. Similar acute toxic effects are observed with sodium tetrachlorophenate. Bioassay tests have confirmed that the commercial sapstain treatment solutions used in British Columbia exhibit a comparable degree of toxicity (9).

In terms of acute aquatic lethality, chlorophenates rank as one of the most toxic industrial chemicals in widespread use in British Columbia. The overflow of chlorophenate solution from dip tanks or holding tanks may cause fish kills in waterways (3). The potential impact of chlorophenate spills is apparent from the observation that concentrate

TABLE 4. THE AQUATIC TOXICITY OF SODIUM PENTACHLOROPHENATE

FISH SPECIES	SODIUM PENTACHLOROPHENATE CONCENTRATION Parts Per Billion (Micrograms/Litre)	EFFECT*
SOCKEYE SALMON	1.7	DIMINISHED GROWTH RATE DIMINISHED FOOD CONVERSION EFFICIENCY
STEELHEAD TROUT (early development stages)	50	100% MORTALITY OF ALEVINS (newly hatched fish with yolk sacs) WITHIN 24 HOURS OF HATCH
RAINBOW TROUT COHO SALMON SOCKEYE SALMON CHINOOK SALMON	32 to 130	50% OF THE TEST FISH ARE KILLED IN 96 HOURS (equivalent to the "Median Lethal Concentration", the 96-hour LC_{50})
SOCKEYE SALMON	300 (static exposure)	100% MORTALITY OF EGGS WITHIN ONE WEEK OF FERTILIZATION

**Aquatic toxicity is strongly dependent upon environmental factors including temperature and pH. Table 4 is intended to be illustrative only and detailed data on aquatic toxicity of chlorophenols and chlorophenates can be obtained from reviews indentified in the list of references (10, 11, 12, 13, 14)*

solutions (7-27% chlorophenate) used at wood protection facilities are still acutely toxic to sensitive organisms even after a million-fold dilution.

2.4.3 Chronic Aquatic Toxicity. Prolonged low-level exposure of fish to chlorophenols can lead to long-term (chronic) effects which are not immediately detectable. Chronic effects on fish include growth retardation and reproductive interference, which are caused by the effects of chlorophenates on the basic cellular metabolism.

Chronic effects on aquatic organisms occur at chlorophenol concentrations far below the level of acute lethal toxicity. For example, diminished growth and reduced food conversion efficiency have been observed with long-term exposure of fish to sodium pentachlorophenate at concentrations as low as 1.7 parts per billion (Table 4).

Although chlorophenols are usually substantially diluted upon entry into the aquatic environment, their chemical stability and persistence are sufficient to result in bioaccumulation of chlorophenols in aquatic organisms (accumulation in the tissues). Chlorophenols typically concentrate in fish tissue to levels about 100 times greater than concentrations in the water to which the fish are exposed. This accounts for the high sensitivity of aquatic organisms to very low chlorophenol concentrations in their environment.

2.5 Human Health Effects

Chlorophenate solutions can be safely used in the workplace if suitable precautions are taken. However, if safeguards are not provided or are inadequate, chlorophenol compounds can enter the human body and may cause short-term (acute) and long-term (chronic) health effects (Table 5).

Occupational illness from exposure to sapstain control solutions has rarely been reported in British Columbia. However, acute poisonings due to excessive exposure to wood protection chemicals have occurred in

TABLE 5. THE SPECTRUM OF HUMAN HEALTH EFFECTS CAUSED BY PENTACHLOROPHENOL

EXPOSURE CATEGORY	RELATIVE LEVEL OF CHLOROPHENOL IN THE BODY*	DOCUMENTED OBSERVED HEALTH EFFECT	
		ACUTE	CHRONIC
GENERAL POPULATION (chlorophenol intake from environmental sources)	1	NONE	NONE
PROPERLY PROTECTED WORKER	1 to 100	NONE	NONE
EXPOSED WORKER WITH SIGNIFICANT SKIN CONTACT	17 to 200	IRRITATION OF SKIN, EYES, UPPER RESPIRATORY SYSTEM	
EXPOSURE TO CONTAMINATED AEROSOLS		INCREASED METABOLISM	
WORKER WITH SIGNIFICANT OVEREXPOSURE	33 to 1000	PROFUSE SWEATING HEADACHES NAUSEA WEAKNESS FEVER INTENSIVE THIRST	DERMATITIS CHLORACNE SUSPECTED DAMAGE TO: KIDNEY LIVER NERVOUS SYSTEM WEIGHT LOSS
MAJOR ACCIDENTAL OVEREXPOSURE	833 to 30000	DEATH FROM HEART FAILURE	

**The "relative level" numbers are based upon urine monitoring data presented in reference 17. The numbers are only intended to illustrate the order of magnitude of chlorophenol exposure that might be experienced under varying conditions of exposure*

Canada and in other countries and are recorded in the literature (14,29). These incidents are invariably associated with a gross misuse of the chemicals (for example, the direct immersion of hands and forearms in chlorophenate solution). Although such incidents are not typical of chlorophenate use in British Columbia, they illustrate the importance of proper practices for handling chlorophenate solutions.

2.5.1 Acute Toxicity. The short-term human response to chlorophenol intake may vary from undetectable (at typical background levels) to death, depending on the dose and numerous other factors (Section 2.5.2). Previous studies cited in Jones (1981) suggest that the general population is exposed to low levels of chlorophenols from the environment and that chlorophenols may be present in the bodies of all humans in the general population (3). This background level is well below the amount of chlorophenol in the human body which could cause detectable acute symptoms of any kind. Increased levels of chlorophenol in the body may lead to the appearance of the symptoms shown in Table 5.

The toxic effects of chlorophenols on humans and other organisms are primarily caused by interference of the chlorophenol molecule with the basic metabolic process of energy production. Acute poisoning in humans is characterized by increased blood pressure, profuse sweating, rapidly developing weakness, excess blood glucose (hyperglycemia), elevated body temperature and death.

The oral lethal dose for humans (based on animal studies) is in the range of 50 to 200 milligrams of pentachlorophenol per kilogram of body weight (13,18). Thus, direct ingestion of 40 millilitres (approximately 1/5 cup) of commercial chlorophenate concentrate by the average adult human could produce severe poisoning or death.

2.5.2 Factors Influencing Acute Health Effects. The type and severity of health symptoms caused by chlorophenates depend on many factors including:

- the duration and manner of exposure (contact with skin, inhalation, ingestion),
- the chemical form, extent of chlorination and concentration of chlorophenols involved, and
- individual sensitivities.

The influence of each of these factors is briefly discussed in the following sections. *It should be clearly understood that acute health effects normally will not occur in the wood protection workplace if suitable worker protection is provided and good practices are followed (Section 3).* Furthermore, minor symptoms of irritation will often forewarn a worker of excessive exposure.

Duration and Manner of Exposure

Chlorophenols can enter the human body through direct ingestion (orally), by inhalation of vapours or droplets and by adsorption through the skin and eyes. Both acute and chronic effects are possible. Repeated exposure to low concentrations can lead to chronic effects, whereas a few minutes of direct contact with concentrated solutions could cause acute chlorophenol poisoning and tissue damage. The strong caustic (sodium hydroxide) in commercial sapstain concentrates contributes to tissue damage caused by short-term exposure to these solutions.

Chemical Form

It is emphasized that the chlorophenates used in the wood protection industry are the water-soluble salts of the corresponding chlorophenol compounds (Section 2.2). The physical and chemical characteristics of chlorophenols and chlorophenates differ significantly. The chlorophenate form used in sapstain control formulations is thought to be marginally less toxic than the corresponding chlorophenol compounds. Since chlorophenol compounds (in solid form and in oil solutions) are used commercially for long-term wood preservation in Canada, care must be taken to distinguish between toxicological information applying to these different chemical forms.

Extent of Chlorination

Due to the higher degree of chlorination, penatchlorophenate is generally considered to be more toxic than tetrachlorophenate. Much of the occupational health data on chlorophenol exposure pertains to the health effects of pentachlorophenate, because this is the primary active ingredient used in wood protection treatments in the United States. Tetrachlorophenate predominates in commercial formulations used in wood protection in British Columbia (Table 3) and data on the effects of human exposure to tetrachlorophenates are still being developed. Until these data are available, precautions for handling chlorophenate solutions (Section 3.1) have been based on information about the toxicity of pentachlorophenate.

Concentration

Experience indicates that symptoms of irritation due to contact with chlorophenate solutions depend on the strength of the solution (17) and protective measures should be determined accordingly (Section 3). Figure 3 shows the potential extent of tissue damage resulting from contact with chlorophenate solutions at different concentrations commonly used in wood protection facilities. The severity and speed of damage are highest with the most concentrated solutions. Both factors diminish as solutions are diluted.

Workers in a treatment facility mav work with solutions ranging from 27% total chlorophenol by weight (formulated concentrates) to very weak solutions of parts per million concentrations (contaminated surface runoff). A single direct exposure to concentrated solutions (10% by weight or greater) can cause serious health symptoms in most individuals. In contrast, even repeated exposure to dilute solutions (less than 0.1%) is unlikely to cause noticeable effects with a person of normal sensitivity, although such exposure may be somewhat more serious to highly sensitive individuals (17).

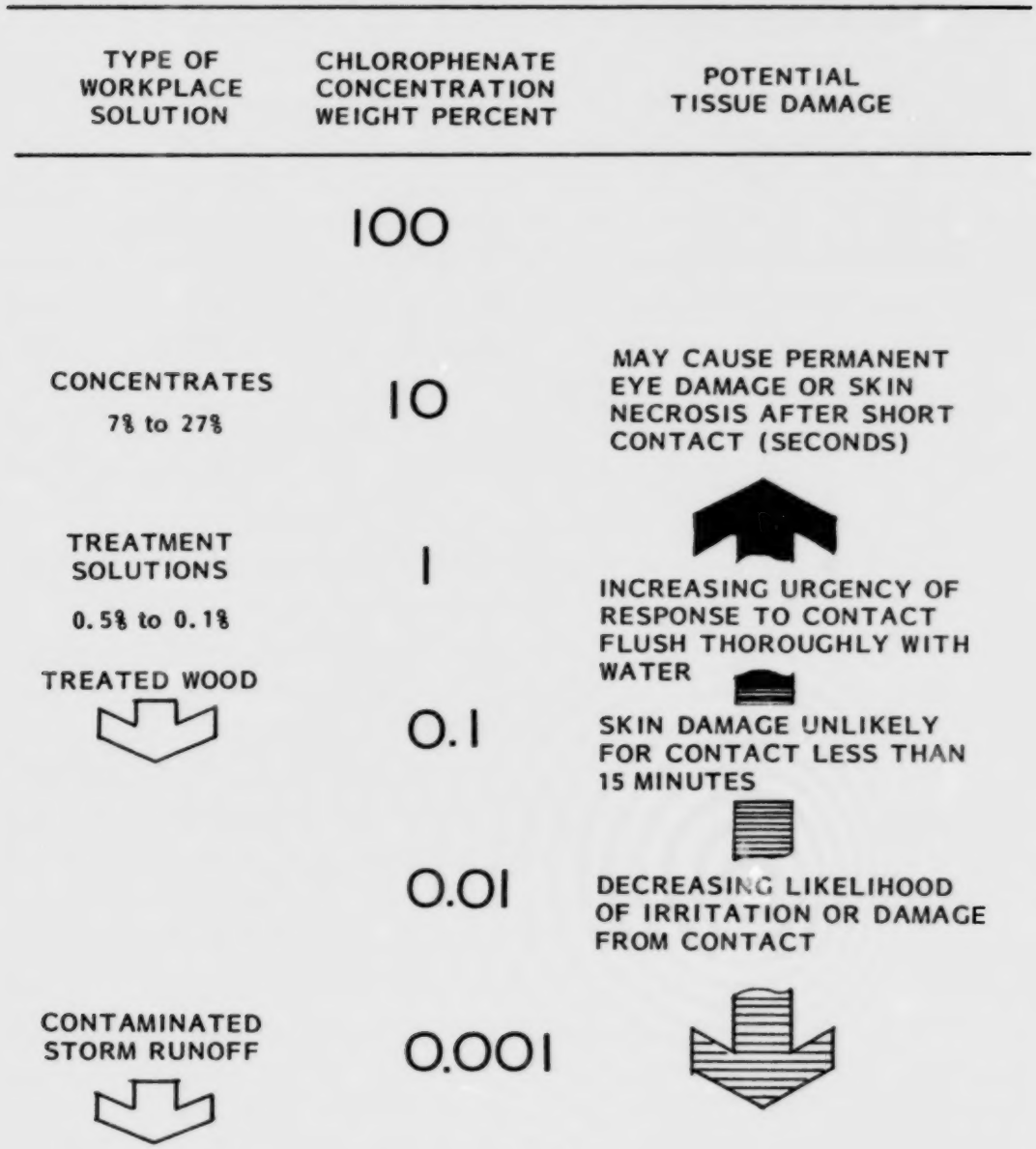


FIGURE 3. HUMAN TISSUE DAMAGE AT VARYING CHLOROPHENATE CONCENTRATIONS*

**Figure 3 is based upon information in references 17 and 19. The figure is intended only to illustrate the general relationship between tissue damage and exposure to chlorophenate solutions over the wide range of concentrations encountered in the workplace. The actual response of individual workers is subject to factors discussed in Section 2.5.2.*

Special Sensitivity

There is a wide range of variation in natural sensitivity to the toxic effects of chlorophenate exposure; some workers may be especially sensitive. This includes individuals with pre-existing skin problems, a history of liver or kidney disease, or a history of metabolic disorders caused by conditions such as diabetes or thyroid disease.

2.5.3 Chronic Toxicity. The symptoms of non-fatal chronic exposures to pentachlorophenol include muscle weakness, headache, loss of appetite, abdominal pain, weight loss, and irritation of skin, eyes and the respiratory tract. Pentachlorophenol does not accumulate in body tissues to a significant extent. Therefore, it is believed that chronic symptoms result from relatively high levels of continuous exposure (13).

The short-term health effects and lethality of exposure to chlorophenols are attributed directly to the toxic effects of the chlorophenol molecule. In contrast, some long-term chronic toxic effects of chlorophenol formulations are thought to be strongly influenced by the presence of certain trace impurities, the chlorinated dibenzo-p-dioxins (dioxins) and chlorinated dibenzofurans (furans) (8,20,21).

Chlorinated "dioxins" and "furans" are actually families of compounds consisting of 75 dioxin isomers and 135 furan isomers. The toxicity imparted to chlorophenols by these impurities is dependent upon the concentration and identity of the specific isomers which are present.

Agriculture Canada has analysed Canadian commercial products containing chlorophenols in order to quantify dioxin and furan impurities. This information will be used to further evaluate the potential human health risk of excessive exposure to wood protection formulations.

Although the nature and significance of impurities in commercial chlorophenols are not well understood, they are currently under intensive investigation. It is known that most chlorophenols do contain dioxins and

furans at parts per million levels. Although the highly toxic 2,3,7,8-tetrachloro dibenzo-p-dioxin has not been found in pentachlorophenol formulations, the presence of other toxic dioxins and dibenzofurans does support the general concern that occupational exposure to sapstain control solutions might cause chronic health effects and underscores the need for implementing appropriate precautions. It is clear that following good practice for handling chlorophenates also reduces worker exposure to any toxic impurities which may be present.

2.5.4 Biological Monitoring of Exposed Workers. Routine biological monitoring of exposed workers can be undertaken using established procedures for the determination of chlorophenols in blood and/or urine (17,22,23). This provides a useful tool for evaluating the long-term effectiveness of protective measures in a given situation. It is important that biological monitoring programmes be carried out and interpreted by appropriately qualified occupational hygienists or doctors.

Detailed information about the significance of pentachlorophenol levels in blood and urine is available (13,24,25,26). The relationship between urine levels in exposed individuals and health effects is illustrated in Table 5. This table is based on information obtained from occupational health studies of pentachlorophenate exposure. Comparable information for tetrachlorophenate exposure is not yet available.

3 PERSONNEL PROTECTION

3.1 Precautions and First Aid

The potential hazards of exposure to sapstain control solutions include immediate and long-term toxic effects from ingestion, skin contact or inhalation of material containing chlorophenates (Section 2.5). A secondary hazard (especially with concentrates) is tissue damage which can result from contact with the strong caustic solution which is used to dissolve the active ingredients.

Figure 3 (Section 2.5.2) emphasizes that increasingly greater caution is advisable as chlorophenate concentration increases above approximately 0.1% by weight. The severity and speed of damage to tissue are highest with concentrated solutions. Both factors diminish as the solution is diluted. The general rule is: *High concentration requires the highest level of protection and immediate response if a worker is exposed to chlorophenate solutions*. If in doubt, play it safe and respond as if exposed to a concentrated solution. Table 7 describes first aid procedures.

Table 6 shows the recommended personnel safety requirements and equipment for typical work activities at wood protection facilities. Note that protection must be provided for all potential types of exposure (eye contact, skin contact, and inhalation) in each activity and many situations require protection against more than one type of exposure. This is especially important when chlorophenate aerosols or droplets are produced. The contact of chlorophenate droplets on the eyes and face can result in significant absorption of chlorophenols into the body. The use of a nose-mouth face piece respirator which does not cover the eyes and facial skin around the eyes may lead to a false sense of security (27). Accordingly, the use of full face shield or full face cartridge respirators is recommended. Table 6 provides a guide for worker protection but good

TABLE 6. SAFETY PRECAUTIONS FOR PERSONNEL WORKING WITH CHLOROPHENATE SOLUTIONS

GENERAL PRECAUTIONS

- KNOW THE HAZARDS OF CHLOROPHENATE EXPOSURE
- PREVENT INGESTION, INHALATION AND SKIN OR EYE CONTACT WITH CHLOROPHENATE SOLUTIONS
- GET IMMEDIATE FIRST AID WHEN CONCENTRATED CHLOROPHENATE CONTACT OCCURS (Table 7)

  The need for protection or first aid generally increases with increasing chlorophenate concentration.
- GET QUALIFIED MEDICAL ADVICE IMMEDIATELY IF SYMPTOMS OF CHLOROPHENATE EXPOSURE APPEAR

PERSONAL HYGIENE

- NEVER CARRY, STORE OR CONSUME FOOD OR DRINK IN WORKING AREAS
- NEVER CARRY OR SMOKE CIGARETTES IN WORKING AREAS
- ALWAYS WASH HANDS THOROUGHLY BEFORE LEAVING WORK AREAS, EATING, DRINKING, SMOKING OR USING TOILET FACILITIES
- CHANGE CLOTHING DAILY; WASH CONTAMINATED CLOTHING SEPARATELY

RECOMMENDED PROTECTIVE EQUIPMENT WHEN:

1. MIXING CONCENTRATE SOLUTIONS
   - Wear impermeable gloves, aprons and boots
   - Wear full face protection with cartridge respirator (Section 3.1)
   - Do not wear contact lenses
   - Provide emergency eyewash and shower in the immediate work area

2. WORKING IN THE DIP AND SPRAY AREA
   - Wear impermeable gloves; wear impermeable aprons and boots if there is a potential for getting wet by chlorophenate solution
   - Wear full face protection if there is a possibility of splashing (Section 3.1)
   - Use a cartridge respirator if the area is not well ventilated
   - Provide emergency eyewash and shower in the immediate work area

3. HANDLING TREATED LUMBER
   - Wear impermeable gloves; wear impermeable apron and boots if there is a potential for getting wet by chlorophenate solution
   - Use eye protection if eye contact with chlorophenate is possible

4. HANDLING CONTAMINATED EQUIPMENT
   - Wear impermeable gloves; wear impermeable apron and boots if there is a potential for getting wet by chlorophenate solution
   - Never weld chlorophenate-contaminated equipment

     Decomposition vapours may be highly toxic
   - Thoroughly decontaminate metal parts if welding is unavoidable and use a full-face shield and cartridge respirator or self-contained breathing apparatus

TABLE 7. FIRST AID FOR CHLOROPHENATE EXPOSURE

EYE CONTACT

FIRST ACTION	*SECOND ACTION*
• IMMEDIATELY FLUSH EYES WITH FLOWING WATER, OCCASIONALLY LIFTING THE UPPER AND LOWER LIDS • FLUSH EYES FOR AT LEAST 15 MINUTES	• USE BORIC ACID SOLUTION AND CORTISONE OPHTHALMIC DROPS • GET MEDICAL ATTENTION

SKIN CONTACT

FIRST ACTION	*SECOND ACTION*
• IMMEDIATELY REMOVE SOAKED CLOTHING OR ARTICLES IN CONTACT WITH THE SKIN • IMMEDIATELY WASH CONTAMINATED SKIN WITH SOAP OR MILD DETERGENT AND WATER	• IF THE SKIN BECOMES INFLAMED (REDNESS, ITCH OR PAIN), GET PROMPT MEDICAL ATTENTION

INHALATION

FIRST ACTION	*SECOND ACTION*
• IMMEDIATELY MOVE THE EXPOSED PERSON TO FRESH AIR (coughing and sneezing occur almost immediately after excessive inhalation of chlorophenates)	• APPLY ARTIFICIAL RESPIRATION IF BREATHING HAS STOPPED • KEEP THE AFFECTED PERSON WARM AND QUIET • GET IMMEDIATE MEDICAL ATTENTION

INGESTION

FIRST ACTION	*SECOND ACTION*
• IF THE PERSON IS CONSCIOUS IMMEDIATELY GIVE THE PERSON LARGE QUANTITIES OF WATER AND INDUCE VOMITTING *Never give liquids to an unconscious person.* *Never cause an unconscious person to vomit.*	• GET IMMEDIATE MEDICAL ATTENTION

judgment should be used in determining the appropriate protection for particular working conditions. The British Columbia Workers' Compensation Board will provide assistance in selecting protective equipment for specific situations.

3.2 Regulatory Controls

Table 8 summarizes the regulatory controls which limit chlorophenate exposure in the workplace in British Columbia. The acceptable level of chlorophenate intake from inhalation exposure is stated in workplace regulations. However, the regulations do not define acceptable amounts of chlorophenate intake from exposure via skin contact or ingestion. Consequently, Table 8 presents additional recommendations in order to more specifically define acceptable levels of chlorophenate exposure in the wood protection workplace. Interpretive comment is presented in the following sections.

3.2.1 Skin and Eye Contact. Workplace regulations governing skin contact with chlorophenate solutions are general in scope. The British Columbia Workers' Compensation Board (W.C.B.) Industrial Health and Safety Regulations (28) do not stipulate safety equipment or procedures specifically for working with caustic chlorophenate solutions. General instructions for handling harmful substances (in this case, caustic and toxic) are specified in Section 12 of the Regulations. In addition, Appendix "A" of the Regulations (Permissible Concentrations of Airborne Chemical Contaminants) carries a "skin" notation for exposure to pentachlorophenol. This indicates "the potential contribution to the overall exposure by skin absorption including mucous membranes and eyes, either by airborne, or more particularly, by direct contact with the substance".

In practice, a wide range of chlorophenate solution concentrations are encountered in the workplace. Workers in wood protection facilities can be exposed to solutions ranging in concentration of total chlorophenate from 27% by weight to a few parts per million. It is recommended that suitable protective equipment and procedures (Section

TABLE 8. ACCEPTABLE LEVELS OF CHLOROPHENATE EXPOSURE IN THE WORKPLACE

ROUTE OF ENTRY	B.C. WCB REGULATIONS*	COMMENT AND RECOMMENDATIONS
SKIN AND EYE CONTACT	Regulations stipulate general precautions applicable to all toxic and caustic substances (Section 10)	COMMENT: • Specific precautions for caustic chlorophenate solutions are not defined • Precautions for chlorophenate solutions differ from precautions with pentachlorophenol/oil solutions • The level of precaution required increases with chlorophenate concentration (Figure 3) RECOMMENDATIONS: • Protective measures (Table 6) should be *mandatory* for workers in contact with solutions exceeding 0.1% chlorophenate • Protective measures (Table 6) are *advisable* for workers in contact with any chlorophenate solution • Sensitive individuals should take special precautions to avoid exposure (Section 2.5.2)
INHALATION	Permissible concentrations stipulated: 8-hour limit 0.5 mg/m³ 15-minute limit 1.5 mg/m³ (Skin notation flags the potential significance of skin absorption)	COMMENT: • Permissible concentrations refer to chlorophenate vapour, but chlorophenate occurs in air also as an aerosol • Chlorophenate aerosols are highly caustic RECOMMENDATIONS: • Respiratory protection and good ventilation should be mandatory: ◦ during mixing operations ◦ when working near spray boxes ◦ when welding contaminated equipment ◦ during any activity which might generate chlorophenate aerosol or vapours from combustion or exposure to heat • Periodic biological monitoring is advisable to verify the effectiveness of protective measures (Section 2.5.4)
INGESTION	No levels stipulated. It is presumed that common sense will prevent ingestion of toxic materials	COMMENT: • No level of oral intake of chlorophenate is acceptable ◦ ingestion of 50 to 200 milligrams of pentachlorophenol per kilogram of body weight could be fatal ◦ precautions shown in Table 6 should be followed

SEE REFERENCE 28

3.1) be *mandatory* for operations involving solutions exceeding 0.1% by weight concentration of total chlorophenate. This includes handling freshly treated lumber and mechanical equipment which has been in contact with chlorophenate solutions. Protective equipment is *advisable* when the presence of material containing any level of chlorophenate is known or suspected. Sensitive individuals should take extra precautions and if possible, avoid any contact with chlorophenate-containing materials (Section 2.5.2).

3.2.2 Inhalation. The W.C.B. Industrial Health and Safety Regulations (28) specify the 8-hour limit for permissible concentration of pentachlorophenol in air as 0.5 milligrams per cubic metre. The corresponding 15-minute limit is 1.5 milligrams per cubic metre of air. These permissible limits are identical to the threshold limit value standards established by the American Conference of Governmental and Industrial Hygienists. The Workers' Compensation Board Regulations state that the permissible limit "refers to the airborne concentrations of substances and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect".

Since wood protection facilities exclusively use water solutions of chlorophenates (as opposed to chlorophenol), the permissible limits must be considered to apply to the dissolved chlorophenate form of the compound. Since the vapour pressure of these compounds is extremely low, the limit effectively applies to suspended aerosols which are generated in working areas. As a final qualification, it is important to remember that concentrated chlorophenate solutions are highly caustic and this enhances the potential danger if inhalation occurs.

The British Columbia W.C.B. Regulations do not specify limits for tetrachlorophenol, the primary active ingredient of B.C. wood treatment formulations. Pentachlorophenol is generally more toxic than tetrachlorophenol, and it must be assumed that applying the limit for the

more toxic substance to total chlorophenols will provide an additional margin of protection.

Concern about inhalation of chlorophenate aerosols is greatest with mixing and handling operations involving concentrates and in areas of the plant where sprays are applied. Workers' Compensation Board monitoring records indicate that actual concentrations have generally been well within permissible limits at B.C. facilities (29).

3.2.3 Ingestion. Oral intake of chlorophenate is dangerous and unacceptable at any level. Ingestion of chlorophenate-containing materials is highly unlikely if workers follow elementary rules of good hygiene and common sense. Direct intake of pentachlorophenol can be fatal at levels of 50 to 200 milligrams per kilogram of body weight (Section 2.5.1). Acceptable limits of ingestion are not prescribed by regulation since there is no valid reason for any such intake to occur.

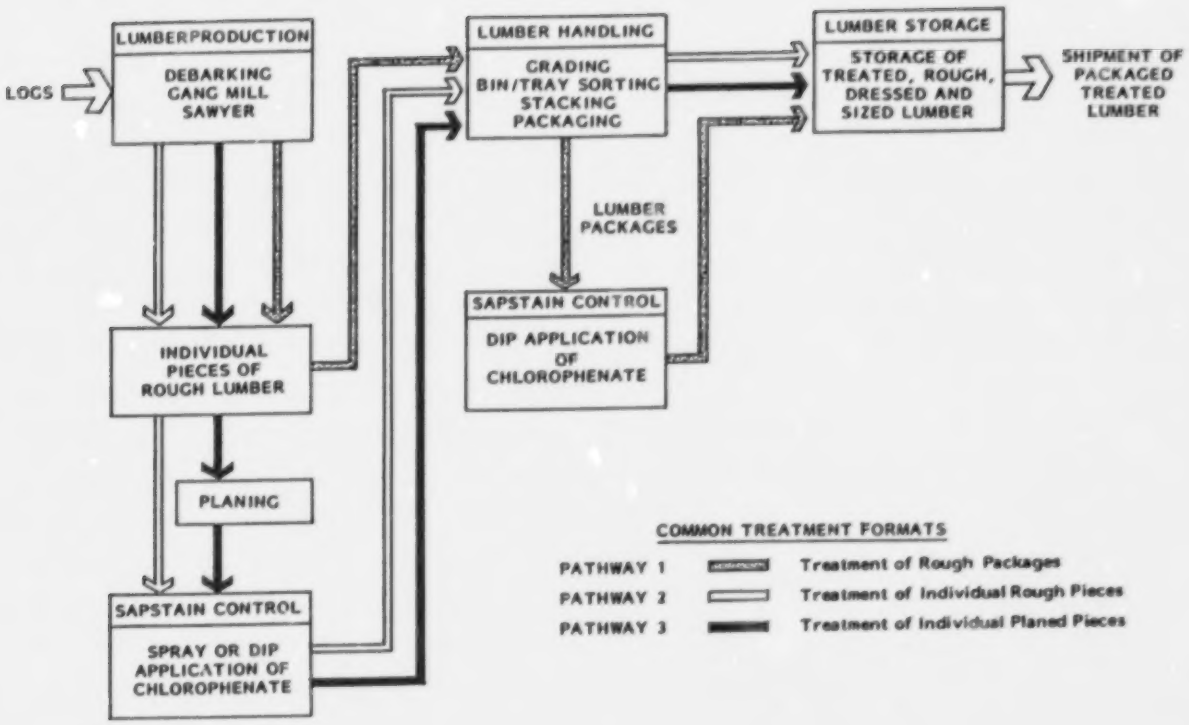


FIGURE 4. THE PRODUCTION OF CHLOROPHENATE-TREATED LUMBER

4 GENERAL PRACTICES AT WOOD PROTECTION FACILITIES

4.1 The Production of Treated Lumber

The production of packaged, chlorophenate-treated export lumber from logs is illustrated in Figure 4. All logs entering the sawmill are debarked, sawed and trimmed to lumber of the desired size, graded, sorted and packaged for storage and shipment. Chlorophenate solution is applied to the lumber at some point prior to shipment in order to control sapstain and mould fungi. The specific chlorophenate application method and point of application in the overall process varies from mill to mill. The three most common treatment formats are illustrated in Figure 4.

Pathway 1. Rough lumber is packaged and then treated by immersing the bundles in a dip tank of chlorophenate treating solution.

Pathway 2. Individual pieces of rough lumber are treated prior to grading, sorting and packaging. In this case, lumber pieces pass continuously through a small dip tank or spray box.

Pathway 3. Individual pieces of rough lumber are planed and then treated individually in a continuous dip or spray system prior to grading, sorting and packaging.

All three of these patterns of operation are commonly encountered at sawmills in British Columbia. In addition, rough, treated lumber may be bundled and stored if the sawmill production exceeds the planer capacity. This wood will then be retreated with chlorophenate after planing, as will any treated lumber which has been subjected to recutting, trimming or remanufacture. Dip treatment of lumber may also take place at export terminals which receive untreated bundles of lumber from a sawmill.

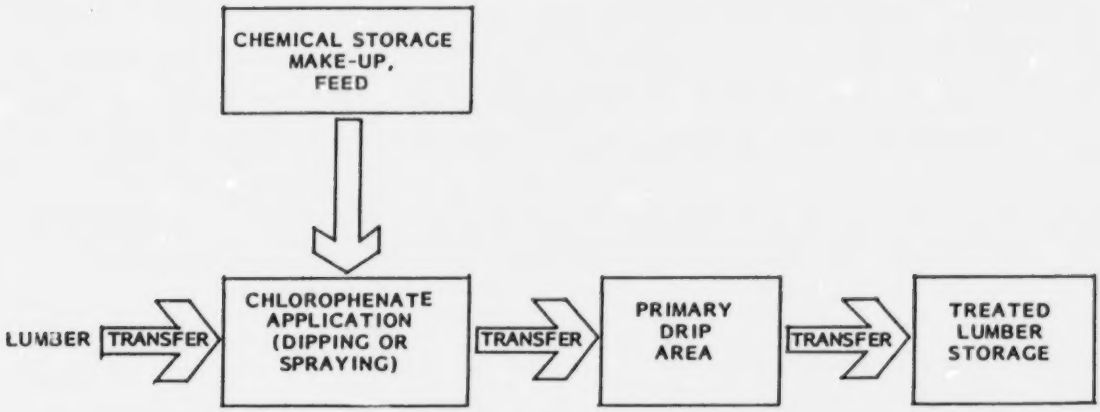


FIGURE 5. PROCESS STEPS FOR THE TREATMENT OF LUMBER WITH CHLOROPHENATE SAPSTAIN CONTROL SOLUTION

4.2 The Treatment of Lumber with Chlorophenate Sapstain Control Solutions

4.2.1 General Process Description. Figure 5 shows the general process steps for applying chlorophenate solution to lumber to control sapstain. Although the individual components for each step vary greatly in practice, the basic operations consist of applying the chlorophenate solution to the lumber by dipping or spraying, followed by transfer through a primary drip area to a treated lumber storage area. Most of the excess or free chlorophenate liquid drains from the lumber in the primary drip area immediately following the treatment step. In some cases the drippage occurs in a distinct drainage area set aside for that purpose; in other systems drippage simply occurs in transit between application and storage (for example, along a transport chain or roller conveyor). Chlorophenate solutions are delivered to sawmills as a 7 to 27 percent by weight concentrate which is generally stored in bulk tankage at the treatment site. The concentrate is diluted to a working solution concentration of 0.5 to 1 percent prior to treating the wood. The systems for concentrate storage, working solution make-up, and chemical feed are described after the discussion of specific chlorophenate application systems.

4.2.2 Specific Chlorophenate Application Systems. An Environmental Protection Service industrial survey of chlorophenate use practices (September 1980) identified 57 chlorophenate application facilities (1). The specific chlorophenate application systems most commonly used include the following:

Dip Systems:

- Drive-In (Carrier) Dip Tanks
- Automatic Elevator Operated Dip Tanks
- Sorting Chain Dip Tanks
- Forklift-Mechanical Dip Tanks

Spray Systems:

- Controlled (High) Pressure Spray Systems
- Low Pressure Spray Systems

The treatment systems can generally be categorized by type of chlorophenate application method: dipping or spraying. All dip systems except sorting chain dip tanks are batch systems designed for treating large loads or bundles of lumber at one time. These systems are characterized by large dip tank volumes (thousands of litres) and transport vehicles or mechanisms designed to handle large loads of lumber. In contrast, sorting chain dip tanks and spray systems are used to treat individual lumber pieces. The lumber is moved through the treatment device by a chain, roller, or belt conveyor system.

DIP SYSTEMS

Drive-in (Carrier) Dip Tanks

Drive-in systems use a lumber carrier vehicle to treat stacks of rough (unplaned) lumber. The stacked lumber is picked up by the carrier and driven down a ramp into a large, concrete tank containing the chlorophenate solution (Figure 6). Vehicles are often rocked to achieve better contact between the top layers of lumber and the treatment solution. After dipping, the carrier exits from the dip tank and deposits the lumber load on the sloped exit ramp to facilitate drainage of excess solution back into the tank.

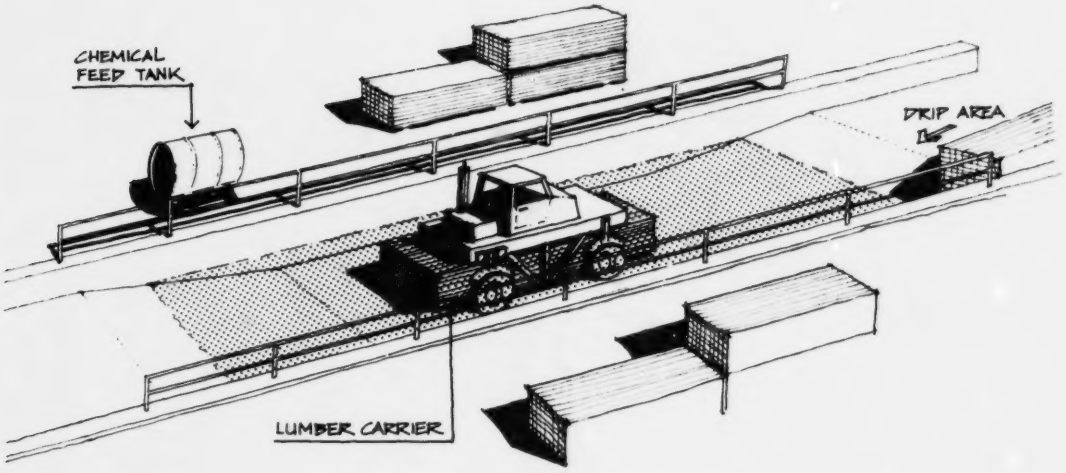


FIGURE 6. TYPICAL DRIVE-IN DIP TANK

Automatic Elevator Dip Tanks

Automatic elevator systems provide conveyorized, automated treatment of bundled lumber. Lumber bundles move through the treatment area on a chain-driven roller conveyor (Figure 7). The bundle is stopped above the dip tank on an isolated segment of the conveyor. The entire conveyor segment and bundle are then hydraulically lowered into the dip tank. Overhead hold-down bars on the platform stabilize the load and force it under the treatment chemical when the conveyor platform is lowered. The platform is then raised to its original level and the load continues along the conveyor over drip pans which collect initial drainage from the treatment bundle. The treated load is then conveyed to a holding platform to await pickup by a forklift and transported to the storage yard.

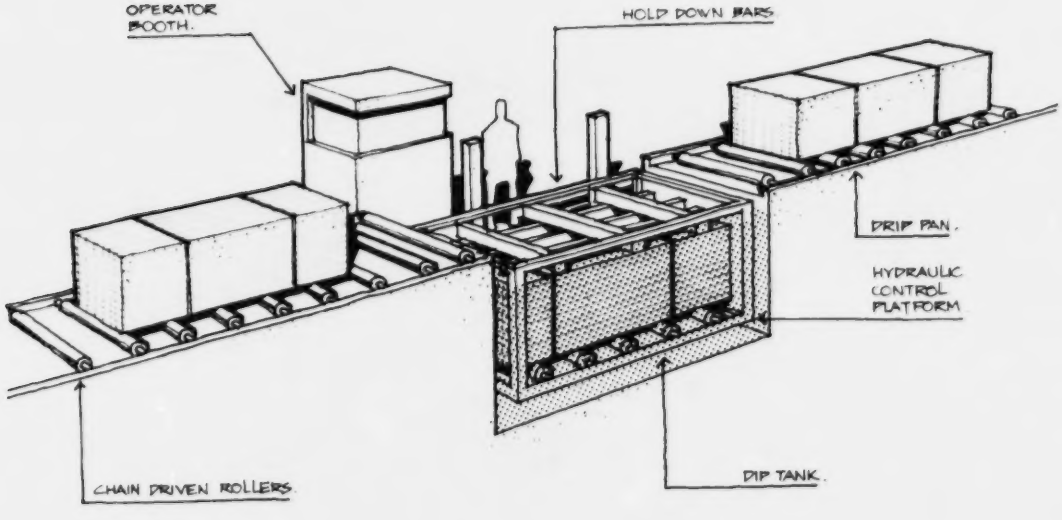


FIGURE 7. TYPICAL AUTOMATIC ELEVATOR DIP TANK

Sorting Chain Dip Tanks

The sorting chain dip tank is an in-line system used to treat individual pieces of planed or rough lumber. Sprocket-driven transport chains are used to carry lumber through the system with the length dimension perpendicular to flow (Figure 8). Metal or rubber hold-down wheels submerge the lumber in treatment chemical as it passes through the dip tank. The transport chain then conveys the lumber to a grading area located next to the treating area.

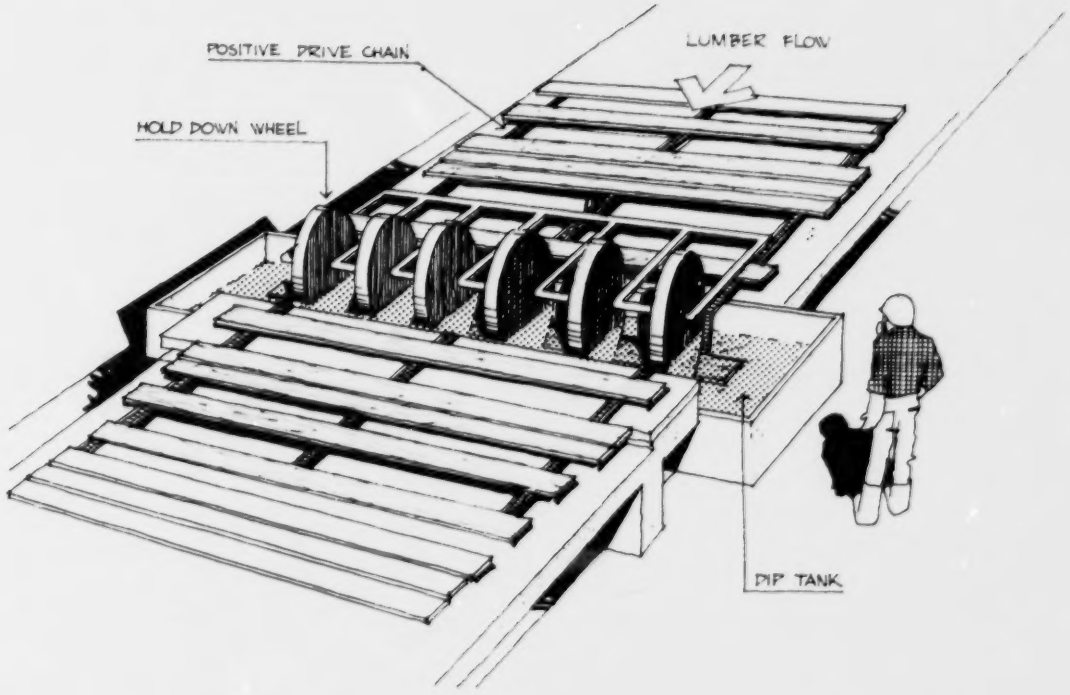


FIGURE 8. TYPICAL SORTING CHAIN DIP TANK

Forklift-Mechanical Dip Tanks

These systems provide dipping of lumber bundles in a hydraulically-operated frame which is loaded and unloaded with a forklift (Figure 9). After a lumber bundle is loaded on the frame, a hold-down bar is positioned above the load to force immersion when the frame is lowered. A variation of the forklift-mechanical dip system utilizes forklift hydraulics to dip the lumber bundle. The dipping sequence is frequently automated. After dipping, the treated bundle is removed from the frame and placed on an adjacent, sloped dripping area to collect free chlorophenate solution. Drainage from the dripping area is collected in a return drain at the base of the tank wall and returned via a collection sump to a holding tank. The accumulated drippage and contaminated surface runoff are used for makeup of treatment solution for the dip tank.

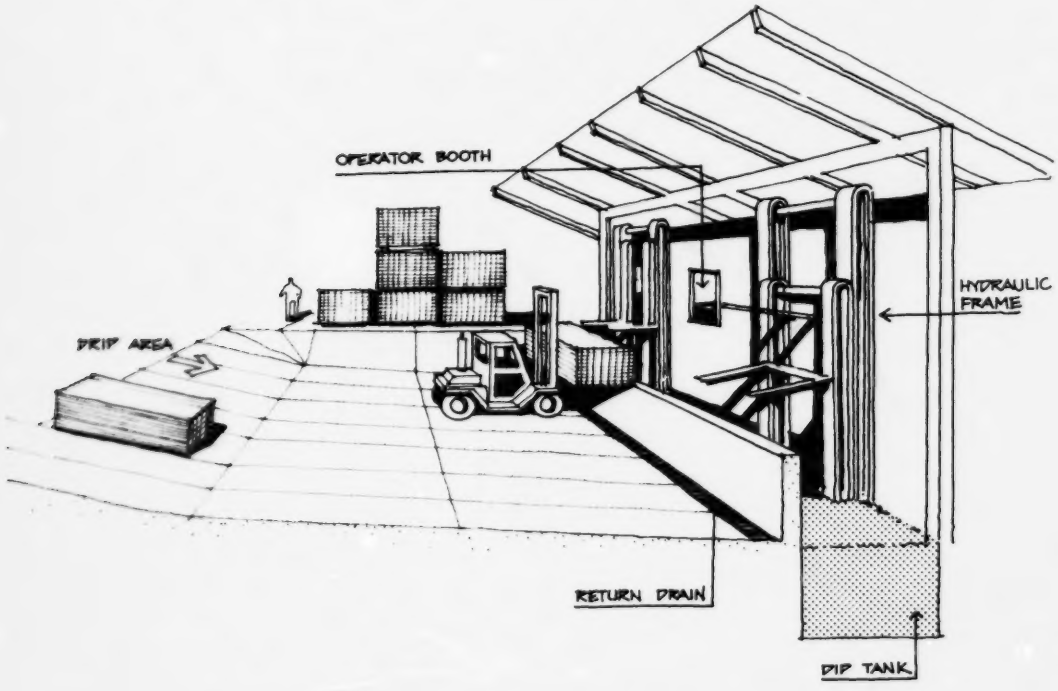


FIGURE 9. TYPICAL FORKLIFT-MECHANICAL DIP TANK

SPRAY SYSTEMS

Chlorophenate spray systems provide continuous in-line treatment of individual pieces of rough and planed lumber. Spray boxes are normally located near the planer exit and the lumber is moved through the unit by a conveyor. High linear rate systems (150 to 275 linear metres/minute) are most common. These systems use a high-speed conveyor belt to move unrestricted lengths of lumber end-to-end through the spray box (Figure 10). Slower cross-chain systems are also in use. The cross-chain system conveys the lumber through the box edgewise, perpendicular to the direction of movement.

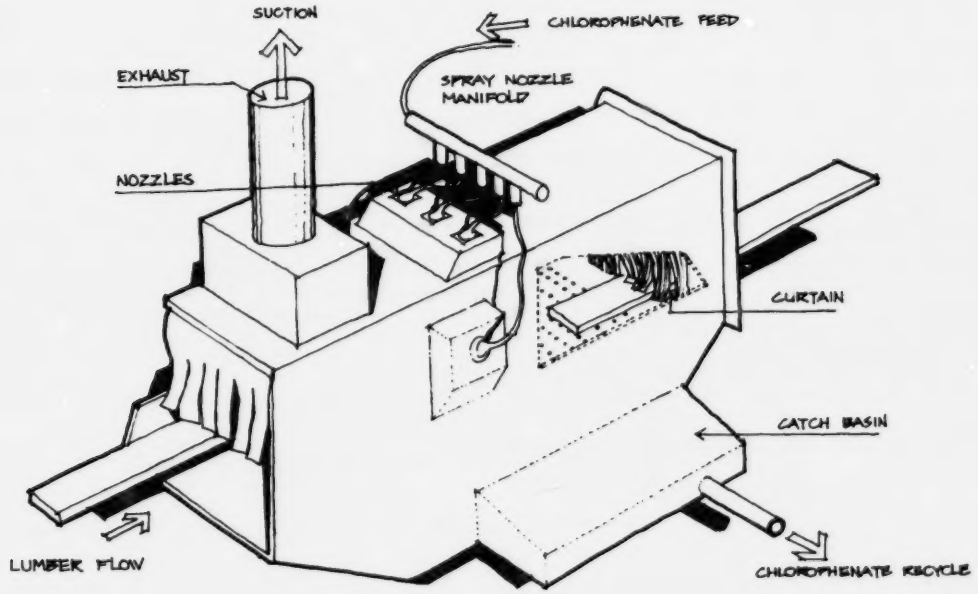


FIGURE 10. TYPICAL SPRAY BOX

Spray systems are frequently categorized by the range of applied nozzle pressures. High pressure or "controlled-pressure" systems (1034-2069 kpa; 150-300 psi) use airless nozzles to apply a mist of fine droplets in the spray box. High pressure nozzles are most frequently used in high linear rate systems. These are commonly referred to as "controlled-pressure" spray boxes because of the adjustable spray pressure.

Low-pressure systems (172-414 kpa; 25-60 psi) use large aperture nozzles in the spray box to apply a surface spray consisting of much larger droplet size than that produced by high pressure nozzles. Low pressure sprays are usually applied in slower cross-chain systems and the carry-over of free liquid on the treated lumber is high relative to high pressure sprays.

Spray systems require special safeguards to isolate the chlorophenate spray. All spray boxes use flexible isolation brushes or curtains on entrance and exit openings to contain the spray droplets. The spray box is also maintained under negative pressure to prevent the escape of entrained aerosols through the spray box openings.

There are 35 spray box installations in British Columbia (1). Many of these are custom designed, although package systems have been developed and sold successfully in recent years.

4.2.3 Chlorophenate Storage, Make-up and Feed Systems.

Dip Tank Facilities

Chlorophenate solution storage facilities for dip tank systems are relatively simple. Most facilities store chlorophenate concentrate in metal free-standing horizontal cylindrical tanks (usually 2,000 litres or greater capacity). The concentrate is typically 7 to 27% total chlorophenol by weight of the total concentrate ingredients. Delivery of concentrate is normally by direct filling from a bulk tanker truck.

Concentrate storage is generally located adjacent to the dip tank and the concentrate is added by gravity flow directly to the dip tank and diluted to a working concentration of 0.5 to 1% total chlorophenol.

The extent of protective measures for concentrate storage tanks varies greatly from site to site. Some existing facilities provide no mechanical protection or spill containment and free-standing tanks are located on unprotected ground. Other facilities provide isolation and dyking of solution storage areas. Tanks are generally non-enclosed and unroofed.

Some facilities provide segregation of stormwater from dyked storage areas or primary drip areas. This contaminated runoff is diverted to tankage and stored for use as makeup water for dip tank solutions.

Spray Facilities

The chemical feed and recycling components for modern spray systems are sophisticated and complex relative to most dip tank facilities. The principal components of a well-designed system are shown in Figure 11. Feed solution for the spray box is prepared by diluting chlorophenate concentrate in a mixed feed tank. The best available systems use automatic proportioning pumps to control the ratio of dilution water and concentrate. Interlocks are provided to block concentrate flow if the water flow is interrupted. Liquid level float switches are used to prevent overflow of feed solution from the mixing feed tank.

Solution is drawn from the feed tank by a positive displacement feed pump, filtered (to prevent nozzle clogging) and delivered to the spray nozzle manifold(s). Overspray which condenses in the box drains to a bottom collection tray. The liquid is drained, settled and/or filtered to remove debris and recycled to the feed tank for re-use.

The spray box exhaust which draws off aerosol overspray is normally connected to the mill suction or cyclone system which captures shavings from the planer. In some cases, an overspray condenser (demister) removes chlorophenate aerosols from the exhaust air and the liquid is returned to the spray feed tank. Other installations exhaust the overspray directly to the mill suction system or vent directly to the atmosphere.

Many variations of the systems described above can be found in existing facilities. The sophistication, complexity, condition and reliability of specific systems depend strongly on the system's age and specific requirements at the site of installation.

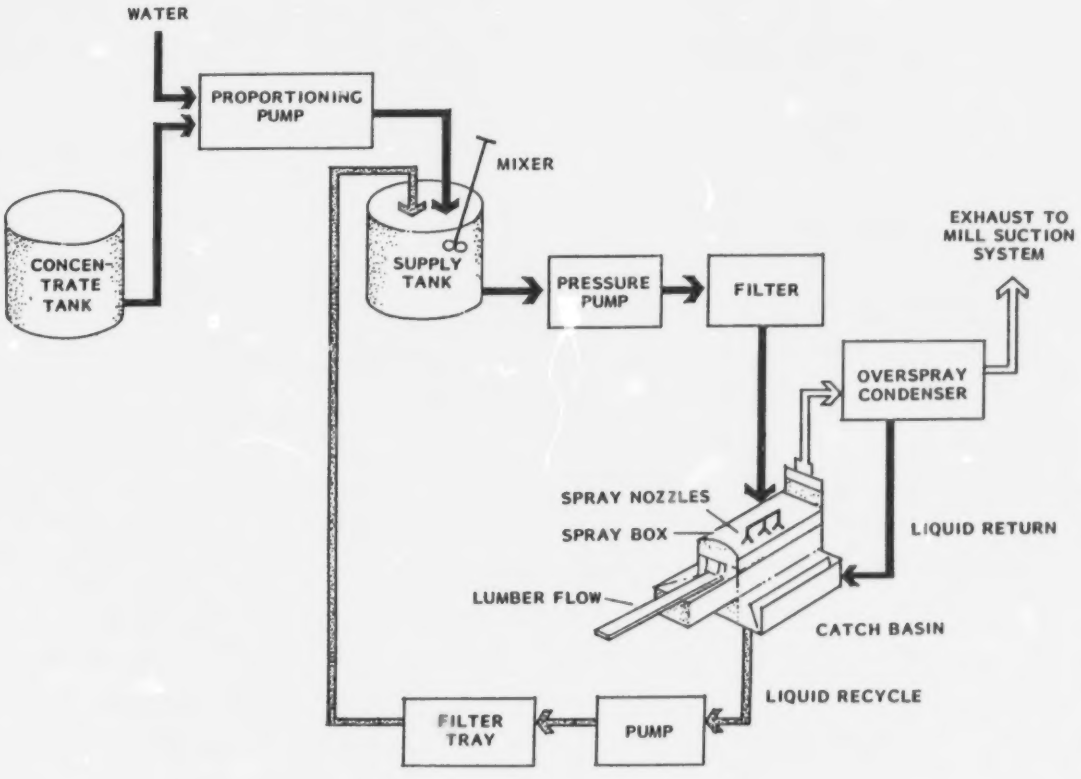


FIGURE 11. TYPICAL CHLOROPHENATE SPRAY SYSTEM

4.2.4 Treated Lumber Storage Areas. Treated lumber at existing wood protection facilities is generally placed in uncovered storage areas and control of drainage from these areas is atypical. Many facilities have not addressed the potential contamination of yard surfaces or surface runoff with chlorophenate which may be washed from treated lumber by rainfall. As described in Section 5.2, monitoring studies have been undertaken by both industry and government to clarify the safeguards necessary to prevent inappropriate releases of chlorophenate from treated lumber to the environment.

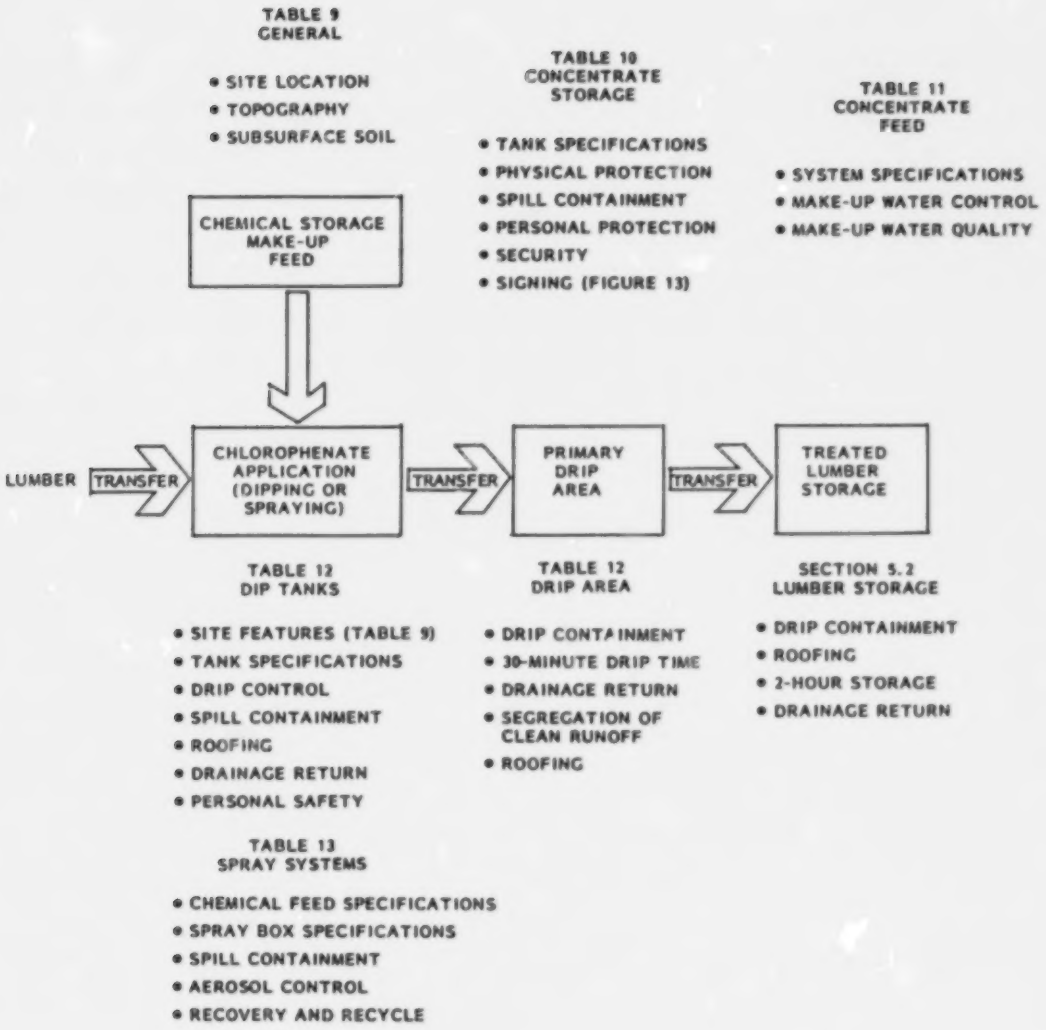


FIGURE 12. OVERVIEW OF DESIGN FEATURES RECOMMENDED FOR WOOD PROTECTION FACILITIES

5 RECOMMENDED DESIGN FEATURES

5.1 Design Recommendations for Chlorophenate Storage, Feed and Application Facilities

The high aquatic toxicity of chlorophenates dictates the need to protect groundwater and surface waters from contamination by wood treatment solutions (Section 2.4). Similarly, the toxicity of chlorophenates to humans dictates the need to protect workers from harmful exposure to sapstain control solutions (Section 2.5). A high degree of protection for both workers and the environment can be achieved through careful implementation of the design features which are presented in this section.

The specific objectives of these design features are:

1. Prevent direct contact of personnel with chlorophenate solution;

2. Provide secure containment of chlorophenate solution in the application area of the facility;

3. Minimize carry-over and spillage of chlorophenate solution from the treatment area; and,

4. Contain and collect spills and drips of chlorophenate solution carried over from the treatment area.

The design recommendations for wood protection facilities are presented in Tables 9 to 13. Figure 12 presents an overview of the key design recommendations for each process step at wood protection facilities. The Figure is cross-referenced to indicate the Table which details specific design recommendations for the highlighted feature.

The recommendations for siting wood protection facilities (Table 9) are explicitly intended to apply only to new facilities. The relocation of existing facilities is not suggested unless the current location poses an unacceptable environmental risk which cannot be satisfactorily reduced by design modifications or operational safeguards.

It is intended that the recommended design features (or features equivalent in effectiveness) will be incorporated into the design of all new wood protection facilities. Existing facilities should retrofit with the recommended features where possible. When retrofitting is prevented by specific circumstances, equivalent protection to workers and the environment should be provided through the installation of alternate safeguards.

5.2 Recommendations for Treated Lumber Storage Areas

It has been common practice to store freshly-treated lumber on unprotected ground in unroofed storage yards. In view of the high solubility of chlorophenate solutions, environmental agencies have expressed concern about potential releases of sapstain control solutions to the environment in uncontained, contaminated surface runoff. These concerns are reinforced by a monitoring study conducted in British Columbia during 1979. The study indicated that eight of nine wood protection facilities were discharging contaminated storm runoff with chlorophenate concentrations as high as 11 parts per million (7).

Earlier laboratory studies have demonstrated that the immersion of freshly-treated wood in waters caused all of the applied pentachlorophenate to be washed or leached from the wood (30). These laboratory studies have also demonstrated that pentachlorophenol is rapidly "fixed" by acidic conditions in the wood. The scientists who conducted the study concluded that "if treated lumber is given a minimum of shelter for a reasonable time, the binding of the chlorophenol will be enhanced and thus the leaching potential will be reduced".

The leaching of sapstain control chemicals (including tetrachlorophenate) from treated wood has not been verified in a controlled practical situation and the Environmental Protection Service has commissioned a study to simulate the exposure of treated lumber to leaching by rain (31). It is anticipated that the results of this study will provide a basis for estimating the minimum time period required for fixation of chlorophenates under cover before they are transferred to an open lumber yard for storage. Pending the results of this study, it is recommended that:

1. treated wood be stored under cover for a minimum period of 2 hours following the initial 30-minute drip period specified in Table 12,

2. the storage area be roofed, paved and curbed, and,

3. infiltrating precipitation be collected and re-used as make-up water for preparing fresh treatment solutions or treated to remove the chlorophenates.

These interim recommendations are subject to review when the proposed leaching studies have been completed. It is intended that both existing and new facilities will implement the recommended features and procedures (or their equivalent).

TABLE 9. RECOMMENDED CRITERIA
Siting New Wood Protection Facilities

SITE FEATURE	RECOMMENDATION
PROXIMITY TO WATERBODIES	• ISOLATE THE FACILITY FROM SURFACE WATERBODIES Provide a separation of at least 50 metres to the nearest surface water • AVOID SITES WITH HIGH GROUNDWATER TABLES Determine the site hydrogeology prior to construction
SOIL COMPOSITION	• SELECT UNDERLYING SOILS WHICH ARE IMPERMEABLE OR HIGHLY ABSORPTIVE Impermeable clays are preferred Adsorptive soils (high in peat or humus content) are acceptable Obtain expert opinion on soil composition, placement and site preparation prior to construction
TOPOGRAPHY	• SELECT SITES WITH SLOPE GRADIENTS LESS THAN 10%

TABLE 10. RECOMMENDED DESIGN FEATURES
Chlorophenate Concentrate Storage Facilities

DESIGN FEATURE	RECOMMENDATION
TANK SPECIFICATIONS	• USE STRONG CORROSION-RESISTANT MATERIALS • INSTALL ACCURATE FLUID LEVEL INDICATORS Protect sight gages against impact/breakage • INSTALL CONNECTIONS FOR DIRECT BULK DELIVERY • PROVIDE DRIP COLLECTION AT POTENTIAL LEAKAGE POINTS • PREVENT INTERIOR TANK ACCESS BY PERSONNEL
TANK LOCATION	• ISOLATE FROM WATERBODIES Allow at least 50 metres • PROVIDE ACCESS FOR BULK DELIVERY VEHICLES • ISOLATE FROM HIGH-USE TRAFFIC AREAS
PHYSICAL PROTECTION	• ENCLOSE THE TANK IN A SEPARATE BUILDING • PROTECT EXTERIOR TANKS WITH: Roofs (see spill containment) Guard rails (vehicle impact protection) Fencing (security) • INSTALL SECURE MOUNTING BRACKETS/ANCHORS Do not use free-standing tanks
SPILL CONTAINMENT	• PAVE AND DYKE SURFACES BENEATH TANKS Provide containment for full tank contents • ROOF EXTERIOR TANKS (To prevent accumulation of contaminated rainwater)
PERSONNEL PROTECTION	• VENTILATE ENCLOSURES • PROVIDE WASH-UP SINKS • INSTALL ACCESSIBLE EMERGENCY SHOWER AND EYEBATH FACILITIES
SECURITY	• INSTALL LOCKS ON DOORS OR GATES
SIGNING	• PROVIDE CONSPICUOUS HAZARD-WARNING SIGNS ON TANKS AND ENCLOSURE DOORS (See Figure 13)

TABLE 11. RECOMMENDED DESIGN FEATURES
Chlorophenate Concentrate Feed Systems

DESIGN FEATURE	RECOMMENDATION
ALL COMPONENTS	• USE SUITABLE CORROSION-RESISTANT MATERIALS
FEED TANK	• LOCATE IN A ROOFED BUILDING (preferred) • PROTECT EXTERIOR TANKS FROM VEHICLE IMPACT • ANCHOR SECURELY WITH MOUNTING BRACKETS Do not use free-standing tanks • PAVE AND DYKE SURFACES BENEATH TANKS Provide spill containment for full tank contents
FEED PUMP	• INTERLOCK THE FEED PUMP OPERATION AND DILUTION WATER FLOW • PROVIDE AUTOMATIC CONTROL (Concentrate flow proportional to water flow)
PIPING	• MARK AND COLOUR-CODE ALL VALVES AND PIPING • PROTECT WATER SUPPLY LINES FROM CROSS-CONTAMINATION Do not cross-connect concentrate and water lines Suggest the installation of backflow preventers on water lines
MAKE-UP WATER CONTROL	• CONTROL DILUTION WATER ADDITION TO THE DIP TANK Regulate with a float switch and motorized valve • INSTALL A CUMULATIVE FLOW METER
MAKE-UP WATER QUALITY	• REMOVAL OF SUSPENDED SOLIDS IS REQUIRED FOR SPRAY SYSTEMS

TABLE 12. RECOMMENDED DESIGN FEATURES
Chlorophenate Solution Dip Tank Facilities

DESIGN FEATURE	RECOMMENDATION
SITE FEATURES	• SELECT LOCATION, SUBSURFACE SOILS AND TOPOGRAPHY IN ACCORDANCE WITH TABLE 9
DIP TANK SYSTEMS	
RAMP STRENGTH*	• CONCRETE SHOULD BE AT LEAST 30 CENTIMETRES THICK AND MEET CSA STANDARD W/CSA CAN 3-A23.3M77 (4000 psi minimum compression strength)
RAMP SURFACE*	• DESIGN THE INCLINED SURFACE FOR GOOD VEHICLE TRACTION
TANK INTEGRITY	• DESIGN THE TANK TO BE LEAKPROOF
TANK STRENGTH	• CONSTRUCT THE TANK OF CORROSION-RESISTANT STEEL OR CONCRETE • CONCRETE WALLS SHOULD BE AT LEAST 30 CENTIMETRES THICK AND MEET CSA STANDARD W/CSA CAN 3-A23.3M77 • DESIGN THE TANK STRUCTURE TO WITHSTAND THE MAXIMUM ANTICIPATED IMPACT FROM VEHICLES AND/OR LUMBER
TANK DIMENSIONS	(SEE SPLASH CONTROL)
SPLASH CONTROL	• SELECT AND LIMIT LOAD ENTRY AND EXIT RATES TO PREVENT SPLASHING AND WAKE FORMATION • PROFIDE ADEQUATE CLEARANCE BETWEEN TANK WALLS AND MAXIMUM LOADS TO PREVENT SPLASHING (allow at least 30 centimetres) • PROVIDE ADEQUATE TANK DEPTH TO ALLOW FULL IMMERSION OF LOADS WITHOUT ROCKING • PROVIDE SUFFICIENT FREEBOARD TO CONTAIN SPLASHES (a minimum of 45 centimetres with full submerged load) • PROVIDE SPLASH GUARDS AS REQUIRED TO PROTECT OPERATING PERSONNEL

**DRIVE-IN SYSTEMS ONLY (Drive-in systems should not be used at new facilities unless other types of systems are not feasible.)*

TABLE 12 (Continued)

DESIGN FEATURE	RECOMMENDATION
DRIP CONTROL	• THE IMMERSION MECHANISMS SHOULD ALLOW TIME FOR ADEQUATE DRIPPAGE (at least 30 seconds) • SLOPE CONVEYOR LINES (automatic elevator systems) TO ENHANCE DRIPPING OVER THE DIP TANK BEFORE REMOVAL TO THE DRIP AREA
MECHANICAL SAFETY	• PROVIDE MANUAL OVERRIDE SWITCHES FOR ALL AUTOMATED OPERATIONS • AUTOMATIC ELEVATOR OPERATED SYSTEMS SHOULD INCLUDE STOP/START SWITCHES, FOR SECURING THE LOAD, DRIPPING, TANK EXIT AND ALL SUBSEQUENT TRANSFERS VIA THE DRIP-DRY CROSS CONVEYOR TO THE LOADING PLATFORM • SORTING CHAIN SYSTEMS SHOULD BE DESIGNED AND SIZED TO ELIMINATE JAMMING IN THE DIP TANKS
PERSONNEL SAFETY	• INSTALL HAND RAILS ALONG TANK SIDES TO PREVENT ACCIDENTAL ENTRY • PROVIDE WARNING SIGNS DESCRIBING THE TANK CONTENTS • PROVIDE ADEQUATE VENTILATION IN ENCLOSED AREAS WHERE EXPOSED CHLOROPHENATES ARE HANDLED Design to meet WCB Guidelines and Regulations
DIP TANK PERIMETER	
SPILL AND DRIP CONTAINMENT	• PREPARE FOUNDATION SUBSURFACE AS DESCRIBED ON PREVIOUS PAGE (see "Site Features") • PAVE DIP TANK PERIMETER WITH CONCRETE, CURB AND SLOPE TO RETURN DRAINAGE TO THE DIP TANK (directly or via a holding sump) • PROVIDE DRIP PANS UNDER ALL CHAIN CONVEYORS (in automatic elevator operated systems) WITH DRAINAGE RETURN TO THE DIP TANK • PROVIDE DRIP PANS UNDER ALL AREAS TRAVERSED BY THE TRANSPORT CHAIN (in sorting chain systems) • INSTALL HOSEDOWN FACILITIES AT VEHICLE ACCESS POINTS (to drive-in tank systems) Return washwater to the dip tank

TABLE 12 (Continued)

DESIGN FEATURE	RECOMMENDATION
PRIMARY DRIP AREA	
DRIP CONTAINMENT	• PAVE, CURB AND SLOPE THE SURFACES OF THE PRIMARY DRIP AREA TO COLLECT AND RETURN DRAINAGE TO THE DIP TANK (directly or via a collection sump) • SIZE THE PRIMARY DRIP AREA TO ALLOW COMPLETE DRAINAGE OF EXCESS CHLOROPHENATE SOLUTION (allow 30 minutes minimum drainage time) • PAVE AND CONTROL DRAINAGE FOR BIN AND TRAY SORTING AREAS (sorting chain dip tank facilities) • PAVE AND CONTROL DRAINAGE FOR FORKLIFT TRAFFIC AREAS BETWEEN PRIMARY DRIP AREAS AND SECONDARY STORAGE (automatic elevator facilities) ◦ Pave and control drainage at the point where forklifts pick up dipped bundles for transfer to storage
TANK, PERIMETER AND PRIMARY DRIP AREA	
PROTECTION FROM THE ELEMENTS (rain, dust, flyash)	• ROOF THE DIP TANK, TANK PERIMETER, AND TRANSPORT CORRIDORS (to and including the primary drip area for treated lumber) • ROOF BIN AND TRAY SORTING AREAS (sorting chain dip tank facilities) • SEGREGATE UNCONTAMINATED RAINWATER AND SURFACE RUNOFF FOR DISCHARGE TO APPROVED STORM SEWERS • PROVIDE FOR RETURN OF CONTAMINATED RAINWATER TO THE DIP TANK (directly or via a collection sump and holding basin)

TABLE 13. RECOMMENDED DESIGN FEATURES
Chlorophenate Spray Systems

DESIGN FEATURES	RECOMMENDATION
CHEMICAL FEED SYSTEM	
CONSTRUCTION MATERIALS (all components)	• SPECIFY CORROSION-RESISTANCE
PRESSURIZED COMPONENTS	• USE A 100% DESIGN SAFETY FACTOR
CONCENTRATE TANK AND CHEMICAL FEED COMPONENTS	• ISOLATE IN A SEPARATE ROOM · Provide spill containment and install controlled drainage (see Table 10)
MIXING TANK	• INSTALL SPLASH GUARDS
CHEMICAL FEED SYSTEM PUMP	• SELECT DEPENDABLE AND PERFORMANCE-RATED PUMPS
NOZZLE PROTECTION	• INSTALL FILTERS DOWNSTREAM OF THE PRESSURE PUMP · Select filters equivalent to or better than motorized self-cleaning units currently in use
PIPING	• INSTALL PRESSURE RELIEF VALVES ON PUMP OUTLETS · Vent to the mixing tank
SPRAY BOX	
LOCATION	• ISOLATE FROM OTHER WORK AREAS · A separate, enclosed room is preferred
SPILL CONTAINMENT	• INSTALL A SEALED CONCRETE FLOOR UNDER THE SPRAY BOX • SEGREGATE DRAINAGE FOR RECYCLE OR DISPOSAL

TABLE 13 (Continued)

DESIGN FEATURES	RECOMMENDATION
SPRAY BOX (continued)	

AEROSOL CONTROL	• COVER EXPOSED AREAS OF THE BOX INLET AND OUTLET WITH FLEXIBLE CURTAINS
	  · Use polypropylene "car wash" curtains or brushes
	• INSTALL AN EFFECTIVE EXHAUST/VENTILATION SYSTEM
	  · Exhaust the spray box to the mill suction and chip transport system
	  · Use an overspray condenser (De-mister)
	  · Ventilate the area in compliance with WCB standards
	  · Safeguard against spray box exhaust reversal into the operations area

BOX CONSTRUCTION	• DESIGN TO WITHSTAND LUMBER IMPACT • PROVIDE INSPECTION ACCESS TO INTERNAL COMPONENTS • PROVIDE AN ACCESSIBLE DEBRIS COLLECTION TRAY • USE REMOVABLE SPRAY HEADERS
RECOVERY AND RECYCLE OF CHLOROPHENATE OVERSPRAY	• RECOVER AND RECYCLE OVERSPRAY, DEBRIS DRAINAGE, DRIPS AND LEAKS TO THE FEED TANK • SCREEN OR FILTER ALL RETURNED LIQUIDS • DESIGN FOR EASY MAINTENANCE WITH MINIMAL EXPOSURE OF PERSONNEL TO CHLOROPHENATE

WASTE MATERIALS	• SEE SECTION 8 FOR DISPOSAL REQUIREMENTS FOR CONTAMINATED LIQUIDS AND SOLIDS
	  · Planer shavings and chips exposed to exhaust air are to be treated as contaminated wastes*
	  · Exhaust the spray box to a suitable incinerator or chlorophenol scrubbing system (do not exhaust directly to the atmosphere)

**MATERIALS NOT USED FOR PULP MANUFACTURE*

6 RECOMMENDED OPERATING PRACTICES

The toxicity of chlorophenate solutions to humans and aquatic organisms is described in Section 2.4 and 2.5. Both workers and the environment can be protected from harmful exposure to chlorophenate solutions through careful implementation of the operating procedures which are presented in this section.

The specific objectives of these operating procedures are:

1. Minimize direct contact of personnel with chlorophenates;

2. Minimize releases of chlorophenates to the environment; and,

3. Provide clear and accurate definition of responsibility and action when emergency response is required.

Recommended operating practices are presented in Table 14 to 17 and include:

- general practices (Table 14),
- procedures for preparing and storing chlorophenate solutions (Table-15),
- pre- and post-shift checks for spray and dip facilities (Table 16), and,
- procedures for the maintenance, cleanout and shutdown of spray and dip systems (Table 17).

It is intended that the recommended practices (or their equivalent) will be adopted by all existing and new facilities which use chlorophenate solutions for sapstain control. Detailed procedures pertaining to each specific facility should be incorporated in a written operations manual which is available to all affected personnel. Responsibility and accountability for implementing procedures should be clearly assigned to specific supervisory and operating personnel.

TABLE 14. RECOMMENDED GENERAL PRACTICES
Operation of Facilities Using Chlorophenate Systems

OPERATION	RECOMMENDATION
PERSONNEL	• TRAIN ALL OPERATORS IN THE SAFE HANDLING OF CHLOROPHENATES • PROVIDE AT LEAST 2 TRAINED PERSONNEL PER SHIFT FOR SPRAY AND DIP OPERATIONS - Trained personnel include foreman or on-scene supervisors
PROCEDURES	• CLEARLY DEFINE OPERATOR RESPONSIBILITIES FOR ROUTINE OPERATION AND EMERGENCY RESPONSE • PREPARE EXPLICIT WRITTEN INSTRUCTIONS FOR OPERATIONS AND MAINTENANCE
SIGNING	• PROVIDE CLEAR AND ACCURATE SIGNING IN ALL CHLOROPHENATE USE AREAS - Identify the contents of chlorophenate equipment by chemical name and brand name - Prominently display personnel safety precautions and first aid procedures (Tables 6 and 7) - Prominently display emergency response procedures
HOUSEKEEPING	• DEFINE AND ENFORCE HOUSEKEEPING STANDARDS - Contain all contaminated debris - Wash down floors or pavement in chlorophenate handling areas - Do not accumulate empty drums or containers
RECORD KEEPING	• MAINTAIN ACCURATE DAILY RECORDS FOR: - Chlorophenate delivery, use and inventory - Equipment condition and maintenance
FIRE FIGHTING	• ADVISE FIREFIGHTERS WHEN CHLOROPHENATES ARE PRESENT IN FIRES - Fires involving chlorophenates can generate highly toxic fumes containing hydrogen chloride and incomplete products of combustion (chlorophenate solutions are not flammable by themselves) • REQUIRE SELF-CONTAINED BREATHING APPARATUS FOR FIREFIGHTERS • PROVIDE AND USE FOAM EXTINGUISHERS (PREFERRED) • CONTAIN AND PROPERLY DISPOSE OF CONTAMINATED FIRE RESIDUES (TABLE 20) - Runoff water, soot and ash from fire areas are *presumed* to be contaminated and should be contained if possible - Dispose of contaminated runoff as a "liquid chlorophenate solution (Table 20) - Dispose of solid fire residues as "high-level contaminated wastes" (Table 20)

TABLE 15. RECOMMENDED OPERATING PRACTICES
Preparation and Storage of Chlorophenate Solutions

OPERATION	RECOMMENDATION
PREPARATION OF CHLOROPHENATE SOLUTIONS	• FOLLOW PERSONNEL SAFETY PRECAUTIONS FOR ALL PROCEDURES (TABLE 6) • ALWAYS PUMP (NEVER POUR) CHLOROPHENATE SOLUTIONS TO AVOID SPLASHING AND SPILLAGE - Use corrosion-resistant centrifugal pumps - Never use chlorophenate pumps and hoses for other jobs • THOROUGHLY RINSE EMPTY CHLOROPHENATE CONTAINERS - Recycle rinse water - Return containers to the supplier or re-use sound containers for storing chlorophenate sludges - Dispose of unusable containers in approved landfills
STORAGE OF CHLOROPHENATE SOLUTIONS	• ASSIGN RESPONSIBILITY FOR STORAGE AREAS TO TRAINED PERSONNEL • PROMINENTLY DISPLAY PERSONNEL SAFETY PRECAUTIONS AND FIRST AID PROCEDURES (TABLES 6 AND 7) IN STORAGE AREAS • PROMINENTLY DISPLAY EMERGENCY RESPONSE PROCEDURES (FIRE OR SPILLS) IN STORAGE AREAS • LOCK STORAGE AREAS AND RESTRICT ACCESS TO AUTHORIZED PERSONNEL • POST NOTIFICATION PROTOCOLS FOR EMERGENCIES • PLACE PLACARDS AT STORAGE ROOM ENTRANCES (FIGURE 13) • LABEL CHLOROPHENATE STORAGE TANKS WITH THE IDENTIFICATION OF CONTENTS BY CHEMICAL NAME AND BRAND NAME

FIGURE 13. SUGGESTED SIGNING FOR CHLOROPHENATE STORAGE AREAS*

**Signs are available from Pesticide Control Branch Office.*

TABLE 16. RECOMMENDED OPERATING PRACTICES
Operation of Chlorophenate Spray and Dip Systems

OPERATION	RECOMMENDATION
*PRE-SHIFT CHECKS**	
CHLOROPHENATE SOLUTIONS IN SPRAY SUPPLY TANKS AND DIP TANKS	• CHECK SOLUTION LEVELS • PERIODICALLY TEST AND RECORD SOLUTION pH · pH must exceed 8 to ensure proper treatment • TEST AND RECORD SOLUTION STRENGTH · Thoroughly agitate solutions before testing (run at least one load through dip tanks) · Use hydrometers for daily tests • CHECK SLUDGE LEVELS IN DIP TANKS · Clean out as required (see Table 17) · Observe personnel safety precautions
AUTOMATIC CHEMICAL FEED SYSTEM FOR SPRAY BOXES AND DIP TANKS	• CONFIRM CORRECT FUNCTIONING
ALL COMPONENTS IN SPRAY AND DIP SYSTEMS	• VISUALLY INSPECT THE COMPLETE SYSTEM FOR LEAKS · Take immediate action to stop leaks
SPRAY SYSTEM FILTERS	• BACKFLUSH CHEMICAL FEED SYSTEM FILTERS · Post and rigidly adhere to manufacturer's requirements · Promptly identify and correct malfunctions • CHECK AND CLEAN RECYCLE SYSTEM FILTER TRAYS
SPRAY SYSTEM	• CONFIRM THE CORRECT FUNCTIONING OF ALL SPRAY NOZZLES · Observe personnel safety precautions
*POST-SHIFT CHECKS**	
CHLOROPHENATE USE	• COMPARE THEORETICAL AND ACTUAL CHLOROPHENATE APPLICATION RATES (chemical use/unit of treated lumber) · Identify and correct discrepancies • COMPARE CHLOROPHENATE INVENTORY CHANGES WITH ACTUAL USE · Identify and correct discrepancies

*ALL PROCEDURES SHOULD BE PERFORMED ONCE PER SHIFT AT THE START OR END OF THE SHIFT AS INDICATED.

TABLE 17. RECOMMENDED OPERATING PRACTICES
Maintenance, Cleanout and Shutdown of Spray and Dip Systems

OPERATION	RECOMMENDATION
EQUIPMENT MAINTENANCE	• MAINTAIN ALL EQUIPMENT IN GOOD OPERATING CONDITION • PREPARE EXPLICIT WRITTEN MAINTENANCE PROCEDURES • FOLLOW PERSONNEL SAFETY PRECAUTIONS DURING MAINTENANCE PROCEDURES (TABLE 6) • AVOID DIRECT CONTACT WITH CHLOROPHENATE SOLUTIONS - Stay clear of spray jets (high pressure sprays can penetrate skin and cause severe internal injury) • DRAIN AND/OR CLEAN CHLOROPHENATE SOLUTIONS FROM EQUIPMENT BEFORE MAINTENANCE - Flush thoroughly with water and/or commercial cleaning agents formulated to remove chlorophenates • USE EXTREME CAUTION IF CONTAMINATED EQUIPMENT MUST BE WELDED (toxic fumes can be generated) - Thoroughly clean surfaces to be welded - Always wear an approved respirator when welding (Table 6)
DIP TANK CLEANOUT	• OBSERVE PERSONNEL SAFETY PRECAUTIONS DURING ALL PROCEDURES (TABLE 6) • CLEANOUT AT 6-8 MONTH INTERVALS OR AS REQUIRED - Heavy use or dirty lumber may cause more frequent cleanout • TRANSFER CHLOROPHENATE SOLUTION TO A HOLDING TANK PRIOR TO CLEANOUT - The use of a bottom scraping device or debris collection system may preclude the need for transferring the solution - Re-use solutions (for disposal see Table 20) • AVOID SKIN CONTACT WITH CHLOROPHENATE SLUDGES - Septic tank type pumping systems are recommended (pumps should not be re-used for other service without complete cleaning) - Wire mesh scoops or lift-out trays may be used • DISPOSE OF SLUDGE AND OTHER CONTAMINATED MATERIALS AS PER TABLE 20
SPRAY SYSTEM	• OBSERVE PERSONNEL SAFETY PRECAUTIONS DURING ALL PROCEDURES (TABLE 6) • DRAIN SYSTEM COMPONENTS PRIOR TO CLEANOUT - Collect and re-use all solutions - If disposal is required see Table 20

TABLE 17 (Continued)

OPERATION	RECOMMENDATION
SPRAY SYSTEM (continued)	• CLEAN SPRAY NOZZLES AS PER MANUFACTURER'S INSTRUCTIONS • THOROUGHLY FLUSH NOZZLE WITH WATER OR CLEANING SOLUTIONS FORMULATED FOR CHLOROPHENATES · Collect and re-use flushing water for preparing new solutions • MINIMIZE WORKER CONTACT WITH CHLOROPHENATE SLUDGES • DISPOSE OF SLUDGES AND CONTAMINATED MATERIALS AS PER TABLE 20
LONG-TERM SHUTDOWN	• COLLECT AND STORE ALL WASH-WATERS FOR RE-USE · If disposal is required see Table 20 • THOROUGHLY CLEAN AND HOSE DOWN ALL EQUIPMENT (INCLUDING VEHICLES) WHICH HAS CONTACTED CHLOROPHENATE SOLUTIONS • CLEAN AND FLUSH ALL PAVED AREAS EXPOSED TO DRIPS OF CHLOROPHENATE SOLUTION • HOLD SOLUTIONS IN TANKS FOR WINTER SHUTDOWN · Securely cover all tanks • RE-USE OF TREATMENT SOLUTIONS AT ANOTHER FACILITY IS PREFERRED IN CASE OF PERMANENT SHUTDOWN · See transportation requirements (Section 7) · If re-use is impossible dispose of according to Table 20

7 TRANSPORTATION OF CHLOROPHENATE-CONTAINING MATERIALS

7.1 Recommended Transportation Procedures

The recommended procedures for safely transporting chlorophenate-containing materials are presented in Table 18. Adherence to these control measures will minimize the potential for accidental release in transit and provide an effective mechanism for safely managing spills if they do occur.

The transportation of chlorophenate solutions and wastes generated by their use is regulated under legislation which is described in Sections 7.3 and 7.4 [the Federal Transportation of Dangerous Goods (TDG) Act and the British Columbia Waste Management Act]. Specific regulations for classifying materials in transit have been gazetted and the requirements are presented in Table 19 and discussed in the following section. However, the specific regulatory requirements for the physical containment, handling, and transportation of chlorophenate-containing materials were not available at the date of printing of this document. Therefore, the procedures recommended herein are based on good operating practice and should be periodically assessed in light of the evolving regulatory requirements.

7.2 Identification of Materials in Transit

Current legislation (Sections 7.3 and 7.4) requires the specific classification and identification of all hazardous products and wastes in transit. Chlorophenate-containing raw materials and chlorophenate-containing wastes associated with the wood protection industry in British Columbia should be identified in transit in accordance with Table 19. Chlorophenate solutions are classified as "sodium pentachlorophenate

TABLE 18. RECOMMENDED PRACTICES

Transportation of Chlorophenate-Containing Solutions or Wastes

CONTAINER SPECIFICATIONS

- DRUMS FOR TRANSPORTING CHLOROPHENATE-CONTAINING MATERIALS MUST BE FREE FROM MECHANICAL DEFECTS

CONTAINER LABELLING

- THE TRANSPORTATION OF DANGEROUS GOODS ACT SPECIFIES LABEL REQUIREMENTS
- AFFIX CLASS 6.1 (POISON) LABELS (FIGURE 14) TO *EACH* CONTAINER
- LABEL *EACH* CONTAINER ON AT LEAST TWO SIDES

VEHICLE PLACARDING

- AFFIX CLASS 6.1 (POISON) PLACARDS (FIGURE 14) TO VEHICLES CARRYING 500 KILOGRAMS OR MORE OF ANY MATERIAL (SOLUTION OR WASTE) CONTAINING CHLOROPHENATE

SECURING VEHICLE LOADS

- REPLACE DRUM SPOUTS WITH LEAK-PROOF BUNGS PRIOR TO TRANSIT
- STRAP DRUMS VERTICALLY TO PALLETS
- STRAP DRUMS HORIZONTALLY TO EACH OTHER
- BRACE OR TIE DOWN THE LOAD TO PREVENT SHIFTING FROM SHOCKS IN TRANSIT
  - Do not rely on vehicle walls or floor to prevent shifting
- ENSURE A STABLE LOAD CONSISTENT WITH VEHICLE FLOOR STRENGTH
- TAKE APPROPRIATE PRECAUTIONS TO PREVENT OTHER LOAD ITEMS FROM PUNCTURING CHLOROPHENATE-CONTAINING DRUMS

DRIVER RESPONSIBILITIES

- KNOW THE NATURE OF THE LOAD
- CARRY SUITABLE EMERGENCY EQUIPMENT AND BE TRAINED IN ITS PROPER USE
- KNOW THE CORRECT PROCEDURES FOR REPORTING ACCIDENTS OR SPILLS:
  - Contact the shipper immediately (the shipper must immediately contact the nearest office of the Provincial Emergency Program)
  - If the shipper cannot be reached, contact the nearest office of the Provincial Emergency Program
  - Know and comply with any other requirements of the shipper/manufacturer
- IMMEDIATELY REPLACE LOST OR DAMAGED PLACARDS OR LABELS (CARRY SPARES)
- NOTIFY THE RECEIVER OF GOODS THAT CHLOROPHENATE MATERIALS ARE IN TRANSIT

TABLE 18 (Continued)

LOADING PROCEDURES

- ENSURE THAT PERSONNEL HAVE THE MEANS AND ABILITY TO MOVE CONTAINERS SAFELY
- SET THE VEHICLE HANDBRAKE SECURELY AND PLACE WHEEL BLOCKS PRIOR TO ON- OR OFF-LOADING
- REQUIRE THE PRESENCE OF A PERSON WHO KNOWS THE HAZARDS OF CHLOROPHENATE COMPOUNDS AND WHO IS TRAINED AND PREPARED TO RESPOND TO EMERGENCIES AND SPILLS
- DECONTAMINATE THE VEHICLE AFTER UNLOADING AND PRIOR TO RETURNING TO SERVICE (when leakage or spill occurs)
- DISPOSE OF ABSORBENTS AND CLEAN-UP MATERIALS IN ACCORDANCE WITH SECTION 8

MANIFEST REQUIREMENTS

- A MANIFEST WILL EVENTUALLY BE REQUIRED BY THE TDG REGULATIONS; SPECIFIC REQUIREMENTS ARE NOT YET DEFINED (see Section 7.3)
- A MANIFEST IS REQUIRED BY THE WASTE MANAGEMENT BRANCH FOR THE TRANSPORTATION OF CERTAIN WASTES (see Section 7.4)

FIGURE 14. RECOMMENDED PLACARD FOR CHLOROPHENATE LIQUIDS AND CONTAMINATED WASTES IN TRANSIT

TABLE 19. RECOMMENDED PRACTICES
Shipping Identification for Chlorophenate Materials Used in Wood Protection

MATERIAL	SHIPPING NAME	REQUIRED LABEL**	PRODUCT IDENTIFICATION NUMBER	B.C. SPECIAL WASTE IDENTIFICATION NUMBER
SAPSTAIN CONTROL CONCENTRATES (Table 3)	"SODIUM PENTA-CHLOROPHENATE AND SODIUM TETRA-CHLOROPHENATE"	CLASS 6.1	UN 2567	NOT APPLICABLE
WASTES, LIQUID	"CHLOROPHENATE, WASTES, LIQUID"*	CLASS 6.1	UN 2567	20128
WASTES, SOLID	"CHLOROPHENATE, WASTES, SOLID"*	CLASS 6.1	UN 2567	20128

**NOT SPECIFIED BY TDG REGULATIONS BUT RECOMMENDED BY THIS "CODE"*

***SEE FIGURE 14*

and sodium tetrachlorophenate" and identified by the United Nations international identification number UN2567. These materials are designated as a Class 6.1 (poison) hazard classification as described in Section 7.3.

Chlorophenate-containing wastes are to be labelled with the B.C. Waste Management Identification Number 20128 (in addition to the UN2567 label) as described in Section 7.4.

The identification categories shown in Table 19 are the categories recommended by Waste Management Branch of the British Columbia Ministry of Environment and the Environmental Protection Service after consultation with the Transport of Dangerous Goods Directorate of Transport Canada. The exclusive use of the categories identified in Table 19 will ensure clear and consistent identification of sapstain control chemicals and wastes which are transported in British Columbia.

Since other industrial chemicals transported in this province contain chlorophenol compounds, potential confusion arises from the fact that the TDG Regulations specify several products and waste categories which might be applied erroneously to sapstain control chemicals and wastes (for example, solid pentachlorophenol shipped for use in the wood preservative industry). It is stressed that the Provincial and Federal authorities have agreed that these other categories *do not* apply to the chlorophenate solutions currently in use for sapstain control in British Columbia.

The Waste Management Branch should be consulted for guidance if new sapstain control chemicals come into use in British Columbia.

7.3 Requirements of the Federal Transportation of Dangerous Goods Act

The transportation of all hazardous products in Canada is regulated by the Federal Transportation of Dangerous Goods (TDG) Act

which has been proclaimed to "promote public safety and the protection of the environment in the transportation of dangerous goods". Unit I of the *proposed* Regulations was published in the Canada Gazette (Part I) on 19-June 1982.

Unit I principally concerns the classification, documentation and safety marking (labelling and placarding) of dangerous goods. Subsequent units will cover safety standards for the containment of dangerous goods, safety requirements for handling and transporting dangerous goods, and administrative matters. The Provincial Government is responsible for the administration of the regulations for road transport.

The TDG Regulations require identification of the stipulated chlorophenates by United Nations number UN2567. This is a permanently assigned number which will enable containers of chlorophenates to be recognized internationally. The TDG Regulations will not consider subsidiary risks such as environmental hazards for substances assigned to Class 6.1. As a consequence, the legally required labels do not explicitly identify the high acute toxicity of chlorophenates to aquatic organisms.

Additional specific requirements of the TDG Regulations will be stipulated in Units II and III which are still under development. Transporters of chlorophenate solutions should direct questions about the status and implementation of Units II and III to the Waste Management Branch at the address given in Section 7.4.

The TDG Regulations specifically define and classify several waste materials. However, the classification of chlorophenate-containing wastes is not explicit in the Regulations. In view of this, the United Nations number UN2567 has been assigned for identifying these wastes when they are transported within British Columbia (see Section 7.4).

7.4 Requirements of the British Columbia Waste Management Act

A new Waste Management Act was proclaimed in British Columbia on 17 September 1982. The Act provides for a "cradle-to-grave" tracking system for special wastes which are defined in a Special Waste List (see Section 8.5). Solid or liquid wastes containing chlorophenates used in wood protection operations have been classified as "halogenated organic pesticide" wastes. These materials have been assigned a British Columbia Identification Number 20128 Since the Federal Transportation of Dangerous Goods Regulations do not designate a specific waste category for chlorophenate wastes, the United Nations identity number for liquid chlorophenate (UN2567) has been designated as the proper identification for these wastes in British Columbia.

The Waste Management Act requires the use of a manifest system when more than prescribed amounts of special wastes are transported and this applies to the transportation of chlorophenate wastes from the wood protection industry. The wastes will be identified on the manifest by UN2567 and the B.C. Identification Number 20128. The manifest system is currently being used on a voluntary basis and questions about current and future requirements should be directed to:

Environmental Safety Program
Waste Management Branch
Ministry of Environment
810 Blanshard Street
Victoria, B.C.
V8V 1X5
Telephone Number: (604) 387-4321

8 DISPOSAL OF WASTES

Pending the establishment of approved special waste disposal facilities in the Province, the Code has adopted interim guidelines for the disposal of chlorophenate wastes. These guidelines are subject to periodic review or change in light of the ongoing development of specific regulations for managing special wastes in British Columbia (Section 8.5). However, it should be emphasized that *the disposal of any chlorophenate-contaminated waste is subject to specific approval by the Waste Management Branch of the British Columbia Ministry of the Environment.* Questions about the interpretation or applicability of the guidelines should be directed to the nearest Regional Waste Management Branch office. The interim guidelines define four categories of chlorophenate-containing wastes:

- chlorophenate solutions,
- high-level contaminated wood wastes,
- low-level contaminated wood wastes, and,
- contaminated storm run-off water.

Table 20 designates the specific types of waste materials and summarizes the recommended disposal methods for wastes in each category. In order to facilitate classification of waste materials, the categories are defined in terms of process origin rather than in terms of chlorophenate concentration. It is anticipated that new Regulations under the British Columbia Waste Management Act will define special disposal requirements for chlorophenate wastes exceeding specific limits of weight and concentration (see Section 8.5).

8.1 Disposal of Liquid Chlorophenate Solutions

Liquid solutions containing chlorophenate (Table 20) should be re-used as make-up in preparing new treatment solutions. Disposal should be considered only as a last alternative.

TABLE 20. RECOMMENDED PRACTICES
Disposal of Chlorophenate-Containing Wastes

WASTE CATEGORY	EXAMPLES	RECOMMENDATION
LIQUID CHLOROPHENATE SOLUTIONS	CHLOROPHENATE CONCENTRATES CHLOROPHENATE DIP OR SPRAY SOLUTIONS	• *RE-USE* AS MAKE-UP FOR DIP OR SPRAY SOLUTIONS • CONTACT THE WASTE MANAGEMENT BRANCH IF RE-USE IS NOT POSSIBLE
HIGH-LEVEL CONTAMINATED SOLID WASTES	DEBRIS AND BOTTOM SLUDGE FROM DIP TANKS DEBRIS AND SLUDGES FROM SETTLING AND FILTER COMPONENTS OF SPRAY SYSTEMS ANY WOOD WASTE OR WOOD DEBRIS WHICH HAS CONTACTED CHLOROPHENATE CONCENTRATE	• DISPOSE IN A SECURE CHEMICAL LANDFILL WITH PRIOR APPROVAL OF THE WASTE MANAGEMENT BRANCH • HIGH-TEMPERATURE INCINERATION SUBJECT TO APPROVAL BY THE WASTE MANAGEMENT BRANCH (pending final recommendations on incineration of chlorophenate-contaminated wastes) (see Section 8.2)
LOW-LEVEL CONTAMINATED SOLID WASTES	CUTTINGS AND SHAVINGS FROM CHLOROPHENATE TREATED LUMBER SHAVINGS OR HOG FUEL EXPOSED TO SPRAY FACILITY EXHAUST DUCTS	• HIGH-TEMPERATURE INCINERATION SUBJECT TO APPROVAL BY THE WASTE MANAGEMENT BRANCH • DISPOSE IN DESIGNATED SANITARY LANDFILLS SUBJECT TO APPROVAL BY THE WASTE MANAGEMENT BRANCH
CONTAMINATED STORM RUNOFF	ANY STORM RUNOFF OR CONTAMINATED LIQUID DISCHARGE WHICH IS DETERMINED TO BE TOXIC TO FISH TOXICITY IS DETERMINED BY BIOASSAY TESTS ON SPECIFIC DISCHARGES (see Table 4 and Section 8.4)	• *PREVENT* OR MINIMIZE CONTAMINATION OF STORM RUNOFF (see Section 5) • *RE-USE* CONTAMINATED RUNOFF AS MAKE-UP FOR DIP OR SPRAY SOLUTIONS • CONTACT THE WASTE MANAGEMENT BRANCH IF RE-USE IS NOT POSSIBLE

If disposal is required, specific approval for the disposal must be obtained from the Waste Management Branch. No suitable means of disposal are currently available within the boundaries of the Province (see Section 8.5). Solutions to be stored pending disposal should be sealed in leakproof metal containers, labelled and stored in a secure area.

8.2 Disposal of High-Level Contaminated Solids

There are significant unresolved questions about the formation of toxic combustion products during the incineration of chlorophenol compounds. In view of this uncertainty, the preferred means of disposal for high-level chlorophenate-contaminated solids is burial in an approved, secure (hydrogeologically isolated) chemical landfill. Disposal sites meeting these requirements are currently not available within British Columbia. The Waste Management Branch will maintain control over out-of-province disposal by copy of the transportation/shipping manifest. It is the responsibility of the waste generator to obtain and comply with other approvals required by the jurisdiction in which the disposal site/facility is located.

High-level contaminated solids should be stored in leakproof containers while awaiting disposal. Large quantities of highly contaminated solids should be stored in a specially designed area which is curbed and lined with nonpermeable material. The area should be roofed or covered by a plastic leakproof tarpaulin to protect the wastes from precipitation. Any seepage or leachate generated at the site should be contained.

A joint provincial/federal/industry task group is currently studying the thermal destruction of chlorophenol wastes. The focus of the programme is to resolve uncertainties about the production of toxic by-products of combustion (polychlorinated dibenzofurans and polychlorinated dibenzo-p-dioxins) which may be generated during the incineration of chlorophenol compounds. The group will ultimately develop specific recommendations for proper disposal of wastes containing these compounds.

Pending the final development of these recommendaitons, the regulatory agencies will consider specific requests to incinerate chlorophenol-containing wastes on a case-by-case basis. In the interim, the current EPA standards for hazardous waste incinerators will be used as a guideline to evaluate the suitability of these requests. These standards include the requirements for a minimum incineration temperature of 1000°C and a minimum residence time of 2 seconds. Site-specific characteristics of the incinerator will also be taken into account in this evaluation. Incineration of high-level contaminated solids (as defined by Table 20) will require the specific approval of the Waste Management Branch.

8.3 Disposal of Low-Level Contaminated Solids

Low-level contaminated solid wastes (as defined in Table 20) may be disposed of by burning in suitable high temperature, hog fuel boilers or other wood-waste burners as specified by the Waste Management Branch. Alternatively, small quantities of low-level wastes may be disposed of at designated sanitary landfills as approved by the Waste Management Branch.

8.4 Disposal of Contaminated Storm Runoff

Every precaution should be taken to avoid contaminating storm run-off water because chlorophenates are highly toxic to aquatic organisms (Section 2.4). Contaminated run-off should be contained and re-used for make-up of fresh treatment solution. If the disposal of chlorophenate-contaminated run-off is required specific approval should be obtained from the Waste Management Branch. Approval to discharge contaminated run-off may be in the form of a permit issued under the Waste Management Act and the control specifications will depend upon factors such as the volume and frequency of the discharge and the sensitivity of the receiving environment. In addition, the discharge of chlorophenate-contaminated run-off into waters inhabited by fish is subject to the provisions of Section 33(2) of the Federal Fisheries Act. As

a guide, it would be expected that chlorophenol concentrations (total penta- and tetra-) in the order of 100 parts per billion would be acutely lethal to fish.

8.5 Interim Requirements of the British Columbia Waste Management Act

The disposal of chlorophenate-containing wastes is regulated under the provisions of the new Waste Management Act which was proclaimed on 17 September 1982. This Act empowers the Waste Management Branch to regulate the on-site storage, transportation (see Section 7.3) and ultimate disposal of wastes, including chlorophenates, as "special" wastes. Special wastes are those which are potentially hazardous to human health and/or the environment and which require special disposal techniques to eliminate or reduce the hazard. It is intended that the disposal of special wastes will be restricted to approved facilities. Approved facilities are currently not available in British Columbia, although the Waste Management Branch has recently announced the acceptance of a proposal submitted by private industry to develop and operate a special waste treatment and disposal system in this Province.

Draft Regulations under the Waste Management Act consider the total quantity of waste, as well as the concentration, in considering whether or not to class a specific material as a special waste. A waste will be classed as a chlorophenate special waste if:

- the chlorophenate content exceeds 5 grams for waste quantities up to 200-kilograms, or,
- the chlorophenate concentration exceeds 25 parts per million for waste quantities greater than 200 kilograms.

Chlorophenate wastes are exempted from special wastes classification if they fall below the concentration/weight limits designated above. In this instance, special requirements will not be imposed by the Waste Management Act for the disposal of these wastes. However, the

discharge of chlorophenate-contaminated liquids exempted from the special wastes category are still subject to the general provisions of the Waste Management Act (for permits or approvals) and to the provisions of Section 33(2) of the Fisheries Act (see Section 8.4).

9 SPILL CONTINGENCY PLANNING

A major spill of chlorophenate sapstain control solution can cause significant environmental damage. If a spill causes actual physical damage to humans or aquatic organisms, the responsible parties may be subjected to prosecution in the courts and incur substantial fines. It is recommended that facilities which use chlorophenate solutions prepare a detailed contingency plan to ensure that response to spills is safe, rapid and effective. Although the detail of a contingency plan must be facility-specific, the plan should meet several general requirements which are presented in the following sections.

9.1 General Requirements

A Contingency Plan should:

1. Have policy, purpose and organizational structure.
2. Be geared to the most probable spill size.
3. Address the following phases of spill response:
   - discovery and notification;
   - evaluation and initiation of action;
   - containment and countermeasures;
   - cleanup, mitigation and disposal;
   - documentation and cost accounting.
4. Clearly assign duties and roles to responsible personnel and organizations.
5. Encourage the participation of citizen and civic organizations when considering resources at risk.
6. Have procedures for updating the plan on a scheduled basis.
7. Co-ordinate with other chemical spill prevention plans and procedures if appropriate.
8. Be submitted to appropriate government agencies for review.

9.2 Implementation Capability

A Contingency Plan should:

1. Describe location, capability and limitations of cleanup and containment equipment.
2. Pre-arrange for use of the best available cleanup and containment equipment.
3. Identify detailed response options and strategies.
4. Provide for training programmes and regular practice sessions.
5. Detail how communications will be maintained among all parties during response operations.
6. Consider its degree of implementation as a normal prevention procedure (i.e., detail steps to be taken as a routine precaution against spills).
7. Address human safety issues.
8. Assign selected personnel to respond to public and media calls.

9.3 Environmental Protection and Other Liability Risks

A Contingency Plan should:

1. Identify high risk areas and operations.
2. Discuss expected behaviour of spill materials.
3. Identify and priorize critical environments for protection.
4. Detail specific actions planned for minimizing damage to resources.
5. Have explicit standards spelling out what constitutes effective cleanup.
6. Have provisions for responding to spills under all anticipated weather conditions.
7. Pre-arrange all response capability needed for the estimated worst-case spill.

9.4 Action Steps

If a Spill Occurs:

1. *STOP THE CHLOROPHENATE SOLUTION FLOW*
   - use common sense
   - act quickly
   - shut off pumps, close valves, etc.
   - if applicable, shut down mechanical production systems *first* (for example, lumber movement) to prevent injury

2. *WARN PEOPLE IN IMMEDIATE VICINITY*
   - evacuate, if necessary
   - do not allow unauthorized personnel to enter the area
   - provide proper protective equipment for on-site personnel

3. *CONTAIN THE SPILL*
   - block off drains, culverts and ditches
   - surround spilled material with earth, peat, straw, sand, booms, or commercial sorbents

4. *OBTAIN REQUIRED ASSISTANCE FROM:*
   - company personnel (advise at earliest opportunity)
   - fire/police/public works/highways department/contractors (as required)

5. *NOTIFY APPLICABLE GOVERNMENT AGENCIES*
   - prompt notification is especially important for spills which have entered or *may* enter receiving waters
   - Spills to Marine Waters - contact Environmental Protection Service at 666-6100 (Vancouver)
   - All Other Spills - contact Provincial Emergency Program at 387-5956 (Victoria)

6. *COMMENCE RECOVERY, CLEANUP, RESTORATIVE ACTION*
   - as detailed by company procedures

7. *COMPLETE A SPILL REPORT*
   - as detailed by company procedures

10 LEGISLATION SUMMARY

This section describes the principal federal and provincial legislation (Acts and Regulations) which addresses the use and disposal of chlorophenols. The use, transportation and disposal of chlorophenols in British Columbia is regulated or could be regulated under six (6) federal and four (4) provincial Legislative Acts which are as follows:

FEDERAL ACTS

1) Fisheries Act
2) Environmental Contaminants Act
3) Pest Control Products Act
4) Ocean Dumping Control Act
5) Transportation of Dangerous Goods Act
6) Clean Air Act

PROVINCIAL ACTS

1) Waste Management Act
2) Pesticide Control Act
3) Workers' Compensation Act
4) Environmental Management Act

Table 21 presents a brief review of the pertinent sections of the Acts and any Regulations that have been promulgated under those Acts.

TABLE 21. SUMMARY OF LEGISLATION REGULATING THE USE OF CHLOROPHENOLS IN B.C.

LEGISLATIVE ACT AND REGULATIONS (RESPONSIBLE AGENCY)	RELEVANT SECTIONS	COMMENTS
1. Federal		
1.1 Fisheries Act (Environment Canada - Fisheries and Oceans)	*Section 33(2)*	Chlorophenols are deleterious to fish and their habitat; it is therefore an offense to deposit chlorophenols or chlorophenol-contaminated wastes into waters frequented by fish. Other sub-sections of the Act may have application if regulations are developed or if specific information is requested.
1.2 Environmental Contaminants Act (Environment Canada, Health and Welfare, Canada)	*Section 4(1)*	The Act gives the federal government the authority to investigate and collect information on commercial chemicals pertaining to all facets of production, use, and release into the environment. Chlorophenols are currently being investigated to determine the nature and extent of the danger that they pose to human health and the environment.
	Section 8(1)	Pursuant to Section 18 the federal government *may develop regulations* prescribing the maximum quantity of a substance which may be released and the conditions under which the substance may not be imported, manufactured, processed, offered for sale or used.
1.3 Pest Control Products Act and Pest Control Regulations (Agriculture Canada)	*Section 5*	The Act regulates products used for the control of pests and the organic functions of plants and animals. Examples of such products are insecticides, fungicides, molluscides and herbicides. The Act requires that an importer, exporter, manufacturer and distributor of a control product must *register* that product with Agriculture Canada. The Regulations prescribe the registration procedures, the information required to be submitted with an application and they define restrictions on the formulation and composition of the products, packaging and labelling, product distribution and product use. Chlorophenol wood preservative products are fungicides and must be registered with Agriculture Canada.
1.4 Ocean Dumping Control Act Ocean Dumping Regulations (Environment Canada)	*The Act Section 1* *The Regulations Section 5*	The Act provides the federal government the authority to restrict the dumping of scheduled substances into Ocean waters. Schedule I *Prohibited Substances* 1. *Organohalogen compounds.* 2. Mercury and mercury compounds. 3. Cadmium and cadmium compounds. 4. Persistent plastics and other persistent synthetic materials. 5. Crude oil, fuel oil, heavy diesel oil and lubrication oils, hydraulic fluids and any mixtures containing any of them. 6. High-level radioactive wastes or other high-level radioactive matter may be prescribed. 7. Substances in whatever form produced for biological or chemical warfare.

TABLE 21 (Continued)

LEGISLATIVE ACT AND REGULATIONS (RESPONSIBLE AGENCY)	RELEVANT SECTIONS	COMMENTS
		Chlorophenols are organohalogen compounds and are known to be toxic to marine, animal and plant life, and are therefore a prohibited substance.
1.5 Transportation of Dangerous Goods Act and Regulations (Transport Canada)	*Section 4* *Section 5* *Section 26*	The Act was proclaimed in 1980 in order to promote public safety in the transport of dangerous goods, such as explosives, flammable materials and toxic chemicals. Sections 4 and 5 define the offences under the Act and Section 26 provides the federal government the authority to develop regulations and standards. The Regulations, which will be promulgated during the latter part of 1983, will identify specific requirements for documentation (manifests and waybills), packaging and labelling for nine classes of dangerous goods and wastes. Penta- and tetrachlorophenates are Class 6.1 substances.
1.6 Clean Air Act (Environment Canada)	*Section 7(1)* *Section 31*	An Act relating to ambient air quality and the control of air pollution. No specific regulations for chlorophenols.
2. Provincial		
2.1 Waste Management Act (Waste Management Branch of the Ministry of Environment)	*The Act* *Section 3*	The Act provides the Waste Management Branch with the legislative basis for the overall management of industrial wastes for the protection of the environment. A company requires a permit or approval issued by the Waste Management Branch in order to discharge a waste into the environment (applies to liquid effluent discharges, air emissions and solid wastes).
	Section 4	The storage of "special wastes" in excess of specified quantities must be authorized by a permit.
	Section 5	The generator or owner of a waste must complete a manifest form and meet other requirements before transporting special wastes.
	Section 10 & 22	The Waste Management Branch can issue an "order" for a company to carry out investigations to determine the risk to the environment posed by its handling of a polluting substance, the environmental effects of a spill, or to carry out remedial and abatement measures after a spill.
	The Regulations	Special waste regulations will be promulgated during 1983.

TABLE 21 (Continued)

LEGISLATIVE ACT AND REGULATIONS (RESPONSIBLE AGENCY)	RELEVANT SECTIONS	COMMENTS
2.2 Pesticide Control Act and Regulations (Pesticide Control Branch of the Ministry of Environment)	*The Act*	The Act and Regulations are designed to ensure that pesticides are sold and used safely according to label directions in a manner that will not produce an unreasonable adverse effect to the environment.
	The Regulations *Section 4*	The application of a pesticide *on public land* must be conducted by a certified pesticide applicator. A certified pesticide applicator is a person who has successfully completed a course and examination in a specialty field conducted by the Pesticide Control Branch.
	Section 28	There are no specific regulations for the control of chlorophenols at wood protection facilities.
2.3 Workers' Compensation Act Industrial Health & Safety Regulations [Workers' Compensation Board (WCB)]		The Act designates the WCB to be the agency responsible for the prevention of injuries and industrial diseases to workers at their place of employment. The Act empowers the WCB to make regulations which may apply to employers, workers and all persons working in or contributing to the production of any industry within the scope of the Act.
	8.18 *	Adequate direction and instruction of workers.
	8.20	Supervisors are responsible for the proper instruction of workers under their direction. The supervisor must ensure that the work is performed without undue risk to the worker.
	12.01	Signs indicating the presence of hazardous chemicals at spray and dip facilities.
	12.03	Storage of chlorophenols and design and labelling of containers.
	12.05	Emergency wash facilities.
	13.01	Exposure to airborne chlorophenols and measures to mitigate excessive exposure.
	13.05, 13.07	Tests to determine unsafe conditions.
	13.09	Protective measures where workers are in a confined space with unsafe atmosphere.

**Only certain regulations are highlighted. Many other regulations are applicable, including 8.02, 8.04, 8.08, 8.14, 8.22, 8.32, 8.52, 8.58, 8.72, 8.74, 8.84, 12.11, 13.41, 13.57, 14.02, 17.03, 17.05.*

TABLE 21 (Continued)

LEGISLATIVE ACT AND REGULATIONS (RESPONSIBLE AGENCY)	RELEVANT SECTIONS	COMMENTS
	13.07	Ventilation and testing requirements for spray facilities.
	13.37	Design of ventilation systems.
	13.43	Location of exhaust ventilation systems.
	13.47, 13.49	Restrictions on the recirculation of contaminated exhaust air.
	14.16, 14.18, 14.21	Protective equipment for workers handling treatment chemicals or treated lumber.
	14.23	Provisions for respiratory protective equipment.
	68.45	Special procedures for dealing with fires involving chlorophenols.
	76.23	Chemical spills shall be cleaned up under the supervision of persons who are knowledgeable in the hazards and the precautions to be taken.

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